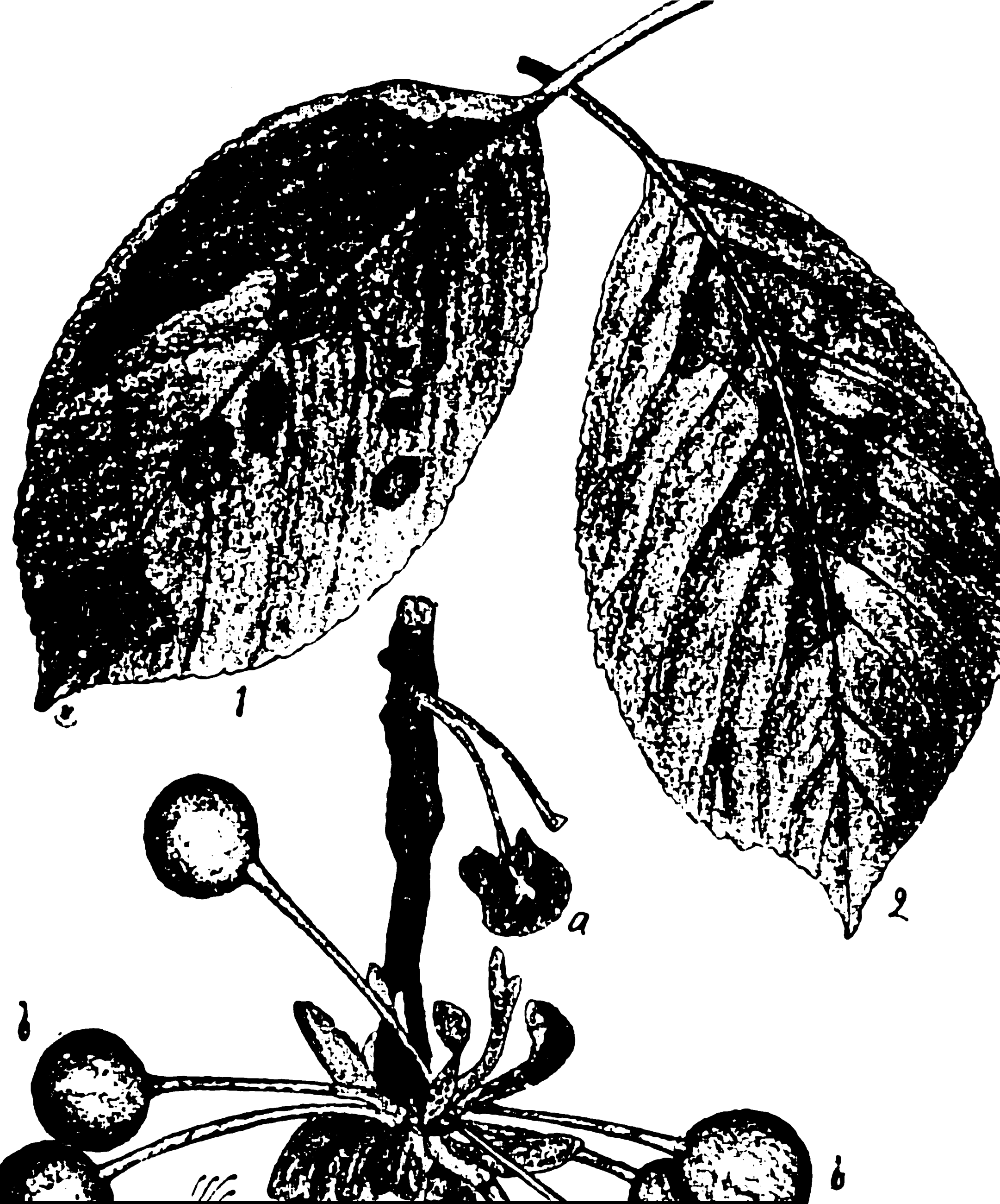

Bulletin

Michigan State University Agricultural Experiment Station

BULLETIN 121. APRIL, 1895.

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION.

The Pests of the Orchard and Garden.

AGRICULTURAL COLLEGE, MICH.
1895.

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OF THE

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L. G. GORTON,
President of the College.

F. B. MUMFORD,
Agricultural College, Mich.

BULLETIN 121. APRIL, 1895.

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STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION.

PESTS OF ORCHARD AND GARDEN.

BY L. R. TAFT AND G. C. DAVIS.

AGRICULTURAL COLLEGE, MICH.
1895.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

MICHIGAN AGRICULTURAL EXPERIMENT STATION.

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South Haven, Van Buren County, 10 acres rented; 5 acres deeded.

BULLETIN 121. **APRIL, 1895.**

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THE PESTS OF THE ORCHARD AND GARDEN.

BY L. R. TAFT AND G. C. DAVIS.

Farmers are beginning to appreciate the fact that, if they would raise paying crops of fruit and vegetables, they must protect them from their insect and other parasites. From time to time we have issued short bulletins regarding some of the more injurious forms, both of insects and diseases, but, as the matter is scattered through a dozen or more bulletins and reports, and as our increased knowledge of their life histories enables us to better prescribe for them, this bulletin upon the subject has been prepared.

The portion relating to insects and the remedies for them was written by the consulting entomologist of the Station, G. C. Davis, and the diseases, fungicides and spraying machinery are considered by the horticulturist, L. R. Taft.

In the calendar we have noted some of the more common fruit and garden crops, and the insects and diseases by which they are infested. We have also endeavored to show the remedies that will be found most efficacious against them and the times at which they should be applied. The more important applications and the ones that will be most likely to be needed are printed in italics. The fruit grower will have to judge for himself, however, as to the number that can be used with profit. In some cases and for some of these crops it will not pay to spray at all, while in others even more applications will be desirable than have been indicated.

In case the material is washed from the plants by rain, it will generally be well to renew the application at once, as it is during wet weather that there is the greatest danger from the entrance of the germs.

FUNGICIDES.

During the past ten years there has been a great increase in the use of various materials for the destruction of the fungous diseases, with which our crops are infested. Previous to 1885, flowers of sulphur was used to some extent for the mildew of the grape and the rose, but today the chemicals used in the preparation of fungicides can only be estimated in hundreds of tons.

The material most commonly used is sulphate of copper or "bluestone," which is applied either as a solution in water or ammonia, or combined with other materials. In the case of most of our tree fruits, it has been found that a strong solution of copper sulphate in water, applied before growth starts in the spring will destroy the spores and the mycelium of such fungi as have wintered upon the outside of the plants, and, by the removal of this source of infection, there will be less danger of the appearance of the disease upon the foliage when it developes. A *weak* solution of the same material late in the season is in some cases desirable. Care should be taken that the dilution is sufficient to prevent injury to the foliage. Upon the naked branches it can be used at the rate of a pound to twenty-five gallons of water, but upon the foliage one pound to two hundred and fifty gallons will be sufficiently strong and, for the peach and other plants with a tender foliage, one-half that strength, or a pound to five hundred gallons, will be as strong as it will be safe to use. The clear solution has the advantage over most of the other preparations of being cheaper and easier to prepare, and besides it does not spot the foliage and fruit.

As it is used today the Bordeaux mixture is the favorite fungicide, as it is very effective and remains for a considerable length of time upon the foliage, even in seasons of heavy rains. It is a mixture of lime and copper sulphate with water, as a result of which the copper is changed into the form of hydrated oxide of copper. This is insoluble in water, and as applied to the plants it is slowly rendered soluble through the action of the carbonate of ammonia of the air.

If a plant is covered with this material soon after the first leaves appear, any spores of fungi that fall upon it will be destroyed as they germinate. It will then only become necessary to keep our plants covered at all times to ward off all danger of attack. While this will be impossible, the nearer we are able to approximate to this condition, the smaller will be the injury.

While the lime aids in holding the fungicide upon the plants, it cannot be applied to fruits within three or four weeks of the time of ripening, and the fact that it renders plants unsightly is a serious objection in other cases, so that, for some purposes, the adhesiveness of the material is a decided drawback to its use. Not only does the lime spot the fruit and render it unfit for food, but the presence of the copper and the arsenites which are often used with it, may, if excessive amounts are used, make it positively dangerous to health.

For all such cases the weak copper sulphate solution mentioned above, or some of the ammonia solutions may be substituted. The ammonia solution of copper carbonate has many friends, for use at this time. While less efficient than Bordeaux mixture, or the copper sulphate solution in water, it has the advantage over the former of not spotting the foliage. The cost, however, is considerably more than for either of the other preparations. While it can be readily prepared by the dissolving of commercial carbonate of copper in ammonia water, and the dilution with the proper amount of water, the cost of the copper carbonate makes it rather expensive. A method of preparing the carbonate of copper from copper sulphate and carbonate of soda is given under "Formulas," which will be but little more trouble and will reduce the cost nearly one-half. As thus prepared, it is the same as what is sometimes called "Modified Eau Celeste."

There are several other materials that are sometimes used as fungicides, but none of them equal in efficiency those named above.

CAUTIONS.

In the use of fungicides and insecticides the following precautions should be observed:

1. Do not mix the copper preparations in iron or tin vessels; always use those of wood, glass or earthen-ware. The valves, piston and cylinder, and preferably all parts of the pump with which the material can come in contact, should be of brass.

2. Do not add Paris green to ammonia containing solutions; always use lime or Bordeaux mixture, especially upon the peach and other trees with tender foliage.

3. When lime is used, slake it carefully and strain through burlap or some similar material. If this is not done the lumps of lime will be likely to clog the pump or nozzle.

4. Never spray with arsenites when the trees are in blossom, as the bees will be killed; they are necessary to fertilize the flowers.

5. Study carefully the nature of the disease or insect and select the remedy that is most likely to destroy it without injuring the plant.

COMBINED INSECTICIDES AND FUNGICIDES.

The expense of the fungicides has been so reduced that the greatest expense in their use is the cost of application. It so happens that for the chewing insects, which include the greater part of those that injure our crops, the arsenites are used. At the time our trees require treatment for this class of insects, we also need to apply Bordeaux mixture for the fungi that threaten them. Not only is it possible to combine the two preparations, and thus save the cost of making one application, but, each will be strengthened by it, as the arsenites can be used stronger without danger of injuring the foliage, when united with the lime of the Bordeaux mixture, while the Paris green is of some value as a fungicide and will make the Bordeaux more effective.

If used with any of the copper solutions it should only be upon plants that are not readily injured, and then only in very small amounts.

The results obtained from the union of kerosene emulsion with Bordeaux mixture and other fungicides are far from satisfactory, but the extent to which this material is used makes it of minor importance.

In the preparation of the combined materials, the same amount of the Paris green should be used, whether alone or combined with the Bordeaux mixture, although a considerably larger quantity could be used in the latter case, without danger of injury to the foliage, should it be deemed necessary.

FUNGICIDE FORMULAS.

BORDEAUX MIXTURE.

Copper sulphate	4 pounds
Fresh lime (unslaked)	3 pounds
Water	40 gallons

Place 6 gallons of water in a tub or barrel and hang in it 4 pounds of pulverized copper sulphate, in a burlap or other coarse sack. Slake the lime, adding water only as fast as it takes it up, and pour together. Before using dilute to 40 gallons. Enough lime should be added to neutralize the free acid, as, if this is not done, it will injure the foliage. To test this, get five cents' worth of ferro-cyanide of potassium (yellow prussiate of potash) at a drug store, and place in a small bottle of water. Add a few drops of this solution to the Bordeaux mixture, before it is diluted, and, if it turns it brown, the lime is deficient and more lime should be added until the ferro-cyanide has no effect. In order to be sure that a sufficient amount of lime has been used, a small quantity should be added after the test shows a sufficiency. When much Bordeaux mixture is used it is an excellent plan to make up a stock solution, which can be diluted as used, proceeding as follows: Dissolve 40 pounds of copper sulphate in 40 gallons of water, and in a box slake 40 or 50 pounds of lime. These can be kept as long as one desires. When needed, measure out 4 gallons of the copper sulphate solution and add some of the slaked lime until no change in color can be produced by the test given above. The mixture will then be ready for use when diluted. The strength of Bordeaux mixture can be varied to a considerable degree. The above formula is about as strong as we care to use at any time, and, after the second application, it is our custom to reduce it by using 50 and even 60 gallons of water for the four pounds of copper sulphate and three of lime. This can be done, with no apparent loss in the efficacy of the Bordeaux mixture, when the fungi are not particularly troublesome, and when several applications are to be made at frequent intervals. If the lime is fresh and a proper amount is added after it has been carefully slaked, there is no danger of burning the foliage with Bordeaux mixture. Another desirable feature about this fungicide is that Paris green can be used with it, thus saving one application, and that the lime also neutralizes any free arsenious acid in the Paris green and greatly lessens its caustic effect. For all fungous diseases of plants, such as mildews, rusts, rots and blights, in which either the spores, or the body of the fungus itself, is exposed to its action.

Some recommend the addition of four pounds of molasses to the lime after diluting it with water and before mixing with the copper sulphate. This remains for a long time on the foliage and is considered very effective.

COPPER SULPHATE SOLUTION.

(A)	Copper Sulphate	1 pound
	Water	25 gallons

For use before the buds open, the above solution is easy to prepare and to apply. It should not be applied to any plant after the leaves burst, as it will burn the foliage. Its action is equal to Bordeaux mixture, but it does not seem as lasting.

WEAK COPPER SULPHATE SOLUTIONS.

(B)	Copper Sulphate	1 pound
	Water	250 gollons
(C)	Copper Sulphate	1 pound
	Water	500 gallons

We have been much pleased with the results obtained from the above weak solutions. Formula (B) can be used without danger of injuring the foliage upon all except the most tender plants, but for use upon the peach, and other tender plants we prefer to rely upon the still weaker solution as given in formula (C).

AMMONIACAL COPPER CARBONATE.

Copper Carbonate	1 ounce
Ammonia	enough to dissolve the copper
Water	12 gallons

Dissolve the copper carbonate in the ammonia and dilute before using. The undiluted solution can be kept in glass-stoppered bottles for some time. The strength of ammonia water generally found at drug stores is 20° Baumé. This will answer as well as the 22° or 26° which are generally recommended, but more of it will be required to dissolve the copper, about one pint being necessary for each ounce of the carbonate.

From the fact that copper carbonate as sold on the market is rather costly, it will be better to manufacture it, if much is to be used. For this take

Copper Sulphate	2 pounds
Soda Carbonate (sal-soda)	2½ pounds

Dissolve these separately in about two gallons of water, pour together and stir thoroughly. A precipitate of copper carbonate will form and sulphate of soda will remain in solution. The water can be poured off and the precipitate dried and kept indefinitely. From the above quantity of copper sulphate and soda carbonate about one pound of dried carbonate of copper will be obtained. It is often used without drying, however, by adding enough ammonia water to dissolve the copper carbonate and diluting to forty gallons. It is then known as *modified eau celeste.*

POTASSIUM SULPHIDE.

Potassium Sulphide (liver of sulphide)	3 ounces
Water	10 gallons

This solution is valuable to use for gooseberry mildew, as it in no way discolors the fruit and is quite harmless.

Like Bordeaux mixture, the last three preparations are for the destruction of fungous diseases, and they should not be relied upon to destroy insects.

INSECTICIDES.

THE ARSENITES—PARIS GREEN AND LONDON PURPLE.

There is little difference in these two insecticides, the former being arsenite of copper and the latter arsenite of lime. The London purple is lighter in weight, mixes more readily with water and is slightly cheaper, but it burns the foliage more readily than Paris green. Each of them contains a small amount of soluble arsenic.

As a Dust.—The arsenites are often used in the dry form with lime, plaster, or flour. About the best rule that can be given as to the proportion to use is to combine them so that only a very faint green or purple tint will be seen in the mixture. This will make the poison in the proportion of one part to one hundred or one hundred and fifty. Care should be used to distribute it evenly over the plants and not apply too much. Air slaked lime seems preferable for the diluent, as it will in a large measure prevent burning of the foliage, should too much of the poison be applied. On low plants this method is quicker and easier in making the application than when applied in the liquid form.

Mixed with Bran.—Many insects, when hungry, will eat sweetened bran with avidity. Arsenic is mixed in the bran and dropped in little bunches where wanted. Great numbers of grasshoppers are killed in this way. Success has been reported with climbing cut worms in the same way. Of course one should be careful of stock and chickens at such a time.

As a Spray.—One pound to 200 gallons of water, or 3 ounces to every 40 gallon barrel is not apt to burn the foliage and proves effectual on leaf-eating insects. Occasionally unaccountable injury will occur and it is always safest to use a little milk of lime in the spraying mixture when the Bordeaux mixture (which already has the lime) is not used. A pound or two of the lime, freshly slaked, to each barrel of the mixture is sufficient. It should be considerably diluted and allowed to settle or else strained into the barrel through burlap, or some coarse cloth, before using, or the dirt and impurities will clog the pump and nozzle in spraying. This lime forms a chemical combination with the soluble arsenic and makes it insoluble. In this condition it kills insects as readily as the soluble arsenic, but does not prove harmful to plant life. Even the tender and susceptible foliage of the peach is not damaged when lime is used.

As a Paste with Lime.—This is becoming an important preparation as a means of protection against borers, especially the peach tree borer. Make a whitewash paste of the lime and put in enough of the poison to slightly tint the paste. After removing dead, loose bark, whitewash the trunks of the trees the last of May, and at intervals after that, as needed. It kills the young borer in eating through the outer bark, and one should be sure to apply as low on the trunk as the borers work.

ARSENATE OF LEAD.

This is a preparation of arsenic that is comparatively new in insect warfare. It is a poison like the other preparations of arsenic, though slower in its effect on insects. The important features that commend it are, it is perfectly harmless to the foliage of trees and plants, even when used at the rate of a pound to a few gallons of water; it will cling to the foliage longer through heavy rains, and it is lighter in weight and will remain more evenly mixed in the water than the other preparations.

Arsenate of lead is not generally found in the drug stores, but the preparation can be made as it is needed. Mr. Fernald gave us the first report of it as an insecticide, and he says:* "A convenient way to prepare this insecticide is to put 11 ounces of acetate of lead and four ounces of arsenate of soda into a hogshead containing 150 gallons of water. These substances quickly dissolve and form arsenate of lead, a fine, white powder which remains in suspension in water.

"It is highly desirable to add two quarts of glucose, or if that cannot be obtained, two quarts of molasses to each 150 gallons of water used, for the purpose of causing the insecticide to adhere to the leaves.

"The experiments with this insecticide both here and in Malden last summer indicate that it will remain on the trees for a long time, even after quite heavy rains."

In Mr. Fernald's experiments, and in other experiments following his, one pound of the arsenate of lead to 150 gallons of water was found to be a mixture too weak and slow to be effective on most insects. Mr. Marlatt found† in his experiments on the elm leaf beetle (*Galeruca xanthomelæna*) that the arsenate of lead gave the best result at the rate of from 50 to 75 gallons of water for each pound. At the above rate this compound of arsenic is more expensive than Paris green or London purple, but for certain insects on plants with tender foliage it is no doubt preferable to the other two.

KEROSENE EMULSION.

This is a common and well known remedy for soft bodied insects that do not feed by chewing, but suck the sap instead. The emulsion is cheap, simple and effectual. It is made of soap, kerosene and water—three ingredients that the farmer always has at his command.

Soft Soap Formula.—Heat a gallon of soft soap until it becomes liquid, then take from the fire, add two quarts of kerosene and agitate for three or five minutes so thoroughly that the soap and oil will become permanently mixed; that is, until the oil will not separate from the soap either on standing or when diluted. A hand force pump should be used in making the emulsion. Slow pumping, or stirring with a stick or spoon will not emulsify the soap and oil.

The emulsion as made is now one-third oil and, for the plants, it should be only one-fifteenth oil, so it will need four times its own bulk of water before using. In other words, the gallon of soap and two quarts of oil will make seven and one-half gallons of the dilute emulsion.

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* Bull. No. 24 of the Hatch Experiment Station of Massachusetts, p. 6.
† "Insect Life," Vol. VII, No. 2, p. 123.

If the emulsion is to be made in the above or greater quantity, it should always be made with soft soap, if that is obtainable, as the emulsion is more difficult to make by the hard soap formula where more water is required.

Hard Soap Formula.—To two quarts of water add one-fourth pound of hard soap, heat to the boiling point and when the soap is dissolved, add the pint of kerosene and proceed as in the soft soap formula. This is one-fifth oil and should be diluted with twice its own bulk of water before using.

CRUDE CARBOLIC ACID.

Where diluted or emulsified, this preparation has some very good insecticidal properties, and is apparently superior to the kerosene emulsion, for certain insects. Always use the *crude* carbolic acid as it is cheaper and quite as effectual as that which is refined.

Carbolic Acid Emulsion.—Mr. Slingerland* has been experimenting quite extensively with this emulsion on the cabbage root maggot and the formula that he recommends is as follows: "One pound of hard soap, or one quart of soft soap, dissolved in one gallon of water, into which one pint of *crude* carbolic acid is then poured and the whole mass agitated into an emulsion, which will remain in this condition for a long time. In treating the plants, take one part of this standard emulsion and dilute it with 30 equal parts of water; it can probably be used stronger without injury to the plants. If the emulsion is cold and semi-solid use several parts of warm water at first."

Carbolic Acid mixed with Soft Soap in the proportion of one part to sixteen of the soap, makes a wash that has been highly recommended for all kinds of borers and for scale insects. The acid may be made into an emulsion and used as a spray if preferred, making the emulsion not weaker than one to ten when diluted.

Mixed with Water, at the rate of a tablespoonful to two gallons of water and sprinkled over the plants, has been found to be a temporary repellant for some insects.

Carbolized Lime is a more lasting repellant. It may be made by slaking fresh lime with carbolic acid in the water at the rate of a teacupful of the acid to each bushel of the lime, or by slaking the lime and then adding the acid. The first method mixes it better, but appears to lose part of its strength in the heating. Half a teacupful of the acid is said, by those who have used this preparation extensively, to be sufficient for tender melon vines and a few other tender plants.

WHALE OIL SOAP.

When dissolved in water, this soap makes a very good wash for trees and destroys many soft-bodied insects. It has a strong odor, and, with its insecticidal ingredients, it is superior to common soap in making emulsions.

* Bulletin 78 of the Cornell University Experiment Station, p. 530.

PYRETHRUM AND BUHACH.

As these powders are harmless to man and all animals that breathe by means of lungs, they are valuable to us at times when other remedies can not be used. The two substances are made from the flowers of a plant closely related to the chrysanthemum and daisy. The dried flower heads are finely ground and this yellowish powder makes our buhach, pyrethrum, Dalmatine and Persian insect powder of commerce. There is comparatively little difference between the buhach and pyrethrum, except that they are from two different species of plants, and the buhach is manufactured at Stockton, California, by the Buhach Manufacturing Co., while the pyrethrum is imported from Persia. The powder has a volatile oil that readily escapes on standing, unless confined in nearly air tight vessels. For this reason the buhach that we can obtain fresh each season is preferable to the imported powder.

As a dry powder is the way the buhach is usually used, and applied by the means of a hand bellows, or else shaken from a piece of muslin. Its effect on insects is still greater when applied in a confined place, as in a tight room or building.

As a decoction in water, it is fully equal, if not superior, to the powder dust. If made in this way, about a tablespoonful should be used to each gallon of water (if hot water can be used all the better), and applied with a spray pump.

BISULPHIDE OF CARBON.

This insecticide, which kills by suffocation, is used by the horticulturist in destroying the pea and bean weevil, ants in their hills and woodchucks; by those who store grain, for the grain moths and weevils; and, by the house wife for the clothes moth, carpet beetle and similar insects. Last season it was tried by several persons quite extensively on plant lice and similar insects with good success. It seems to be a most promising insecticide in many ways.

Bisulphide of carbon is procured in the liquid form, but upon being exposed a short time to the air, it readily changes to a gas and quickly diffuses itself through the air. For this reason it must be confined in a nearly tight jar, box or building to keep it where it is wanted in treating insects. The liquid comes in tin cans of from one pound to fifty pounds each, according to the amount desired. The best plan is to buy of some wholesale druggist, as Edward R. Taylor of Cleveland, Ohio, or some wholesale firm in Chicago or Detroit. It is seldom kept by local dealers, and if so it is usually worthless. It is quite inexpensive when bought at wholesale.

For Grain Insects and Pea and Bean Weevil.—There will be no danger to seeds or grain, for food or next year's seed, in pouring the bisulphide over them and confining all in a tight box for several days. The gas is much heavier than air and will quickly settle through the grain and permeate the whole. Even the odor will escape in a few hours on opening the box to the air. *Great care must be observed in keeping all fire and light from the gas, or near where it is confined, as it is very inflammable, and explosive when ignited.*

SPRAYING

PLANT.	FIRST APPLICATION.	SECOND APPLICATION.
APPLE (*Scab, codling moth, bud moth, canker worm, tent caterpillar, aphis.*)	*Spray before buds start, using copper sulphate solution. For aphis use kerosene emulsion.*	*After the blossoms have formed, but before they open, Bordeaux and Paris green.*
CABBAGE (*Worms, aphis, flea beetle.*)	*When worms are first seen, Paris Green. For flea beetle, plaster or tobacco dust.*	*If worms reappear, repeat if plants are not heading.*
CHERRY (*Rot, aphis, curculio, slug, leaf blight.*)	*As flower buds appear, but before they open, copper sulphate; for aphis use kerosene emulsion.*	*When fruit has set use Bordeaux and Paris green.**
CURRANT (*Mildew, worms.*)	*As soon as worms are found on lower and inner leaves, Paris green.*	*If they reappear, repeat, adding Bordeaux for mildew and leaf-spot.*
GOOSEBERRY (*Mildew, worms.*)	*As leaves open, Bordeaux and Paris green.*	*In 10-14 days repeat with both.*
GRAPE (*Rot, mildews, anthracnose, flea-beetle.*)	*Before buds burst spray with copper sulphate solution.*	*When first leaves are half grown, Bordeaux and Paris green.*
PEACH, APRICOT (*Rot, curculio, leaf curl, mildew.*)	*Before buds swell, copper sulphate solution and Paris green.*	*Before blossoms open, Bordeaux.*
PEAR (*Leaf blight, scab, slug, codling moth.*)	*As buds start, copper sulphate solution.*	*Just before blossoms open Bordeaux* and Paris green.*
PLUM (*Curculio, rot, shot-hole fungus, black-knot.*)	*Cut and burn black knot whenever found. Before buds open spray with copper sulphate solution.*	*As soon as blossoms have fallen, Bordeaux and Paris green.**
POTATO (*Blight, beetles, scab.*)	*Soak seed for scab in corrosive sublimate (2 oz. to 16 gallons of water), for 90 minutes.*	*When beetles or their larvæ appear, Paris green.*
QUINCE (*Leaf and fruit spots, slug.*)	*Before buds open, copper sulphate.*	*When fruit has set, Bordeaux and Paris green.**
RASPBERRY, BLACKBERRY (*Anthracnose, rust, cricket, slug, gall.*)	*Cut out galls, crickets and canes badly diseased with anthracnose. Before buds open spray with copper sulphate solution.*	*When new canes appear, Bordeaux and arsenites.*
STRAWBERRY (*Rust.*)	*Just before the blossoms open, Bordeaux and Paris green.**	*After fruit has set, weak copper sulphate solution.*
TOMATO (*Rot, blight.*)	*If rot or blight appears, Bordeaux.*	*Repeat if disease continues.*

CALENDAR.

THIRD APPLICATION.	FOURTH APPLICATION.	FIFTH APPLICATION.
Within a week after blossoms fall, Bordeaux and Paris green.	*10-14 days later, Bordeaux and Paris green.*	10-14 days later, Bordeaux or weak copper sulphate solution.
After heads form, use hot water or saltpeter (a teaspoonful to gallon of water.)	Repeat, if worms reappear. Use kerosene emulsion for aphis.	
10-14 days later if signs of rot appear, repeat.	10-14 days later, weak copper sulphate solution.	
If worms still trouble, pyrethrum or hellebore.†	After fruit is picked, Bordeaux.	
10-14 days later, sulphide of potass. on English varieties.	10-14 days later, repeat.	If mildew persists after crop is gathered, Bordeaux.
*As soon as fruit has set, repeat.**	*10-14 days later, repeat.*	10-14 days later, if disease is present, apply weak copper sulphate solution.
*As soon as fruit has set, Bordeaux and Paris green.**	*7-12 days later, repeat.*	7-12 days later, repeat.
Within a week after blossoms fall, Bordeaux and Paris green.	*8-12 days later, repeat.*	10-16 days later, weak copper sulphate solution.
10-12 days later, repeat.	*10-20 days later, Bordeaux.*	10-20 days later, weak copper sulphate solution.
Repeat whenever necessary.	When blight of the leaves is accompanied by rot of the tubers, Bordeaux.	Repeat in 10 days, if necessary.
10-12 days later, repeat.	*10-20 days later, Bordeaux,*	10-20 days later, weak copper sulphate solution, if necessary.
10-14 days later, repeat.†	After crop is gathered remove old canes, thin new ones, and spray with Bordeaux if necessary.	(NOTE—If red rust appears the entire stool affected should be grubbed out and burned.)
As soon as berries are harvested, Bordeaux (if to be kept longer). Repeat, if necessary.	(NOTE—Young plantations should receive Bordeaux at the time of the 2d and 4th applications to bearing plants.)	(NOTE—Use kerosene emulsion for aphides whenever present.)

Enough of the bisulphide of carbon should be used so that the gas will penetrate thoroughly. In large quantities, at least one pound should be used to each twenty cubic feet of space. If the box is not tight, more should be used.

For Ants, make a small hole in the hill, pour in a teacupful of the bisulphide, quickly cover with clay soil and pack it or cover for a few minutes with a wet blanket and then remove the blanket and ignite the gas.

For Woodchucks saturate a ball of cotton with the bisulphide, roll the ball down the hole and close the latter by packing earth over the entrance.

WHITE HELLEBORE

This is a mild vegetable poison which is sometimes used in the place of the arsenites. It may be used either in the powder, by dusting over the plants, or liquid form, at the rate of a heaping tablespoonful to two gallons of water, and applied as a spray.

TOBACCO DECOCTION.

For some insects a tea made of tobacco, or refuse stems, at the rate of one pound to five or six gallons of water, is highly recommended. Boiling water may be turned over the tobacco, or, better, let it steep a short time and strain when cool.

HOT WATER.

This is a remedy which is simplicity itself and needs no explanation for preparation except that most insects are killed by it at a temperature of 130 to 140 degrees. The foliage of some plants will not endure heat much greater than this, while such plants as the cabbage will endure water raised to 180 degrees without injury. Where insects are working near the surface of the ground, as root lice, or at the base of the trunk, as the peach tree borer, water is often used boiling hot with telling effect on the insect without injury to the tree.

THE DISEASES OF PLANTS.

A plant may be considered in a diseased condition when any of its organs are unable to properly perform their normal functions. This may be brought about by a great variety of causes, many of which are beyond our control, such as extremes of temperature, an excess, or a deficiency of moisture, an improper supply of food, either in kind or amount, or, as perhaps is most common, by the work of either insects, fungi or bacteria.

Much can be done by the grower to give the plants a suitable location, soil and food, and this will do much to keep the plants in health, but the influences that affect the nutrition of the plants are by no means all of them under control, and the conditions that in one season may give good results may not be present in another.

While plants that are growing in congenial surroundings are less subject to the attack of parasitic fungi than those that are suffering for lack of them, those that are apparently in the best condition to withstand the

attack of these parasites do not always escape. It is true, however, that if they are abundantly supplied with food they will suffer less from the attack of the fungus than if the food supply is short.

So far as is now known, most of the parasites that prey upon plants are of a fungous nature. Fungi are a low order of vegetable life and most of them obtain their sustenance from other plants or animals. In case their hosts are living they are said to be *parasites*, but if the food comes from decaying organic matter the name *saprophyte* is applied to them. The former are the ones that cause disease in plants, although the saprophytes may appear in living plants, feeding on the tissues that have been destroyed by the parasitic fungi or in any other way.

The body of a fungus consists of a mass of minute, thread-like tissue, to which the name of *mycelium* has been given. These may be found either upon the exterior of plants, in which case they send short, root-like suckers down into the tissues below and thus take up their food, or they may penetrate the bodies of their hosts, where they suck out the sap from the cells and cause their destruction. While most common on the leaves, all parts of plants are subject to attack. When they have reached a certain stage of development, arrangements are made for reproduction. In most cases, a number of short branches are sent out upon which round or oval spores are formed, the number in most cases being very large. These spores are distributed by the wind, and in various other ways, and if they fall upon a moist place on a plant of the same kind a germinating thread will be sent out and a new mass of mycelium will be formed. In many cases only a few hours will elapse from the time the spore drops from its stalk until it has germinated and become a new fungus. These summer spores cannot survive great changes in temperature and moisture and, to carry the fungus over winter, another form known as winter spores is developed by most plants, as the end of the season approaches. These as a rule have thick, firm coverings, and are often buried deep in the tissues of the plants.

When spring approaches, the spores escape from their coverings and the life of the new crop of fungi begins. While in some cases the mycelium survives the winter, there is also, in most cases, a crop of winter spores by which the disease can be distributed in the spring.

While the same conditions do not favor the development of all kinds of fungi, some thriving best when it is hot and dry while with others a cool, moist atmosphere seems most favorable to their development, a certain degree of moisture is necessary for the germination of all forms.

The fungi cause injury to the plants in various ways, as they not only rob the tissues of the food designed for the nourishment of the plant, but, as the cells are ruptured, a large amount of water will be lost by evaporation from the tissues. Oftentimes a large amount of the leaf surface of a plant is involved, and, being unable to perform its normal functions, the assimilating powers of the plant are weakened. When large areas of new stems are involved, the drying out is so deep that the circulation is nearly if not quite cut off and it may result fatally to the plant.

A few of the fungi, such as the powdery mildews, live upon the exterior of plants and can be readily reached by fungicides, but the great majority of them penetrate the epidermis on germinating, and are then beyond the reach of any external application. For all such inside feeders, or *endophytes*, the principal means at hand for combatting them is by the covering of the plants with some material that will destroy the spores and prevent them from sending their germ tubes into the plants. Many forms of fungicides

have been tried, but the ones that have been found most efficacious, are some of the salts of copper.

In most cases nothing more can be done, but there are some diseases which work in such a way that much can be done to prevent their spread, by destroying the infected portions. When this can be done without too great trouble, considerable good will be done.

The bacteria are parasites and saprophytes of an even lower order than the fungi. They are extremely minute, being so small that they can only be seen with the highest powers of the microscope, and consist each of a single cell, although as they multiply by fission, a single individual separating into two, they often remain joined together, forming a sort of chain. Under suitable conditions of light and heat, these minute organisms cause rapid fermentation and the decomposition of nitrogenous matter.

A GLIMPSE AT THE TRANSFORMATIONS AND HABITS OF INSECTS.

What is an insect? Most people, were they to reply to this question, would say: An insect is a small creature that can walk and fly and is found everywhere. Ask a student who has studied insects more closely and he will tell you an insect is a small animal with six legs in the adult stage, which has a distinct head, thorax and abdomen that are held together merely by muscles. Further, he can tell us that an insect has no bony skeleton like the higher animals, but a horny covering with all the muscles, digestive organs, etc., inside of this shell-like armor. By this definition we have greatly restricted the number of animals in our class of insects; yet, insects proper, if they could be counted, would undoubtedly outnumber all other animal life on the earth, even including man. How essential it is then that we should know more of them and their habits and the best methods for their control, especially when they destroy so many million dollars worth of property annually.

TRANSFORMATIONS.

In their development, most insects will be found to pass through four different forms—the egg, larva, pupa and imago.

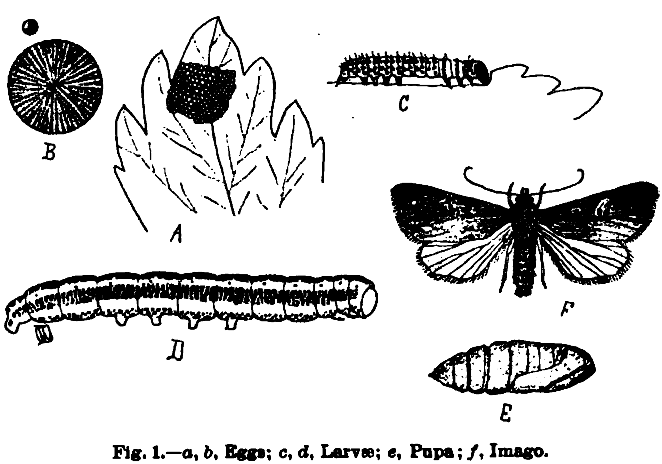


Fig. 1.—*a*, *b*, Eggs; *c*, *d*, Larvæ; *e*, Pupa; *f*, Imago.

The Egg (A and B of Fig. 1).—We are not as likely to find the egg as we are the other three stages, because insect eggs are usually very minute and hard to find. There are some, though, that may easily be seen, as is the case with the slender white eggs of the currant saw-fly, which may be found in the spring by examining the central ridge on

the under side of the new currant leaves, well in toward the center of the bush. Eggs, when placed in a bunch on leaves or twigs, are more readily seen, and it is a good plan to crush all such egg clusters, as they will usually prove to be the eggs of a pest rather than those of a friend. The egg stage with most insects lasts fróm a few days to a week or two, though quite a number remain over winter in this stage.

The Larva (plural larvæ). In this immature and growing stage (C and D of Fig. 1) the insect is a voracious feeder. These larvæ are very small when they first hatch from the egg and for some time they are not noticed; but as they grow larger and eat more they are more conspicuous and their injury is proportionally greater.

Larvæ are commonly spoken of as "worms." This should not be, for true worms such as the angle worm and tape worm are not insects at all, and we misuse the term. There are names by which different forms of the larval stage are recognized that are perfectly appropriate and proper to use. For instance, we speak of the larvæ of beetles, which work in the ground, as *grubs*; the larvæ that bore in wood, as *borers*; the larvæ of butterflies and months, as *caterpillars*, and of some moths as *loopers* or *Geometers*; the larvæ of the two-winged flies, as *maggots* and the larvæ of saw flies, as *slugs*.

The larval period varies greatly with different insects. It is passed by most species in from one to two months in the summer, while others pass through it in a few weeks and still others remain as larvæ over winter, or even for several years (as some of the borers) before passing to the next stage.

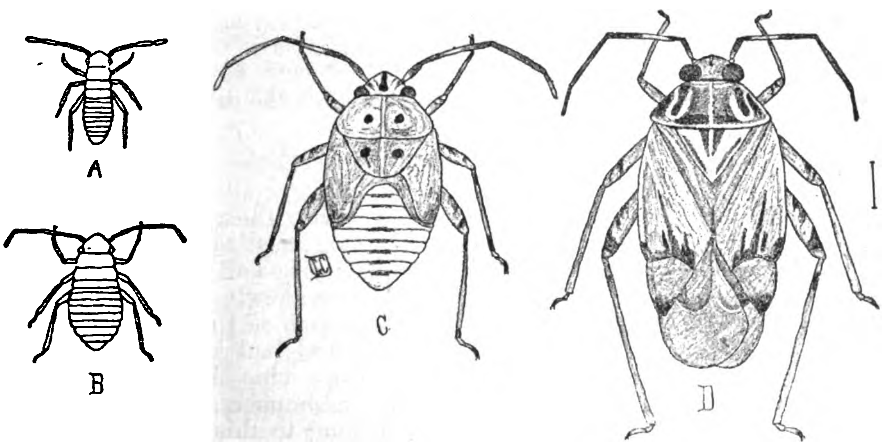


Fig. 2.—Transformation of Plant Bug.

The Pupa (plural pupæ). (See E of Fig. 1). This is known as the *chrysalis* with the butterfly, and with some insects, as the unfledged grasshopper, the *nymph.* It is a condition in which most insects are, to all external appearances, dormant and lifeless, but, inside, there is a great transformation in progress, which will soon change the ugly caterpillar into a beautiful butterfly and the maggot into a fly. Sometimes the larva builds a fine silken cocoon in which to pupate, sometimes it merely draws

some leaves around itself and sews them together for the same purpose, though usually it makes a cell in the earth below the surface and transforms in it. The length of time in this stage is quite variable, as they often remain thus a large share of the year, including winter.

The Imago (F of Fig. 1) *or perfect insect.*—This is the stage in which we most often recognize insects. It is short in comparison with the other three stages, lasting only a day or two with some, but long enough to enable them to lay eggs for a succeeding generation or bring forth their young alive. Insects never grow in this stage.

Such is said to be a *complete transformation* (see Fig. 1) or one where each stage is entirely different from the others. Locusts, grasshoppers and bugs may be said to have an *incomplete transformation* (see Fig. 2), as their different stages of growth are quite similar after leaving the egg. As such an insect grows, it becomes, at times, too large for its skin which then bursts along the back, allowing the insect to crawl out, a new and larger skin growing in its place. With the last moult comes the wings.

HOW INSECTS BREATHE.

Insects do not breathe by means of lungs as do the higher animals. They breathe through minute openings that are scattered in various places over the body. From these openings run minute tubes that carry the air inside to the blood. Not only is their manner of taking air different, but substances that they breathe may affect them readily, while animals with lungs are not affected at all. Thus it is that our pyrethrum and buhach so readily affect insects, while to us it is perfectly harmless. It is not the dust which affects them, but some volatile principle in the oil that probably attacks the nervous system, as it throws insects into spasms as soon as it is breathed. Hellebore will affect insects in the same way, though it is not as likely to be fatal as the others.

DIFFERENT METHODS IN FEEDING.

There are two methods by which insects secure their food, by chewing and by sucking. Those which chew their food masticate it in very much the same way that we do, except that their jaws and other mouth parts move sidewise instead of up and down. To the chewing class belong the greater number of insects. All caterpillars, such as the tent caterpillar, canker worm, peach tree borer, codling moth and bud worms; all beetles, as the potato beetle, apple tree borers, grape vine flea beetle, striped cucumber beetle and plum curculio. All grasshoppers, locusts and crickets, and many others of less importance, belong to this class. For these insects we apply poisons to the parts of the plant on which they feed and they will soon eat enough of the poison to kill them. Of the poisons taken by eating, the arsenites are the best, if they can be applied without danger to ourselves, because they are the most deadly and certain. Hellebore is also an internal poison, but milder and slower to act than the arsenites.

The second class of insects, those that feed by sucking, are not so numerous, but are more difficult to control. The arsenites have no effect on this class of insects. Let us watch a familiar example, the mosquito, that we may see why the arsenites do not affect it. When the mosquito alights on the hand, it presses its pointed beak close to the skin and then runs down a set of hair-like needles inside of this hollow beak and these pierce the skin. Then, without changing the beak, the blood is drawn through it from the puncture to the stomach. Even if the hand were covered with Paris green, the mosquito would not get a particle of the poison in sucking the blood, as the two are entirely separate. The conditions are the same with a large number of flies, to which order the mosquito belongs, and with the whole order of bugs, such as the brown squash bug, yellow lined currant bug, bed bug, lice on stock, plant lice and scale lice. The head and beak of a plant bug are shown in the accompanying cut (Fig. 3), with the needle-like parts drawn from the tube.

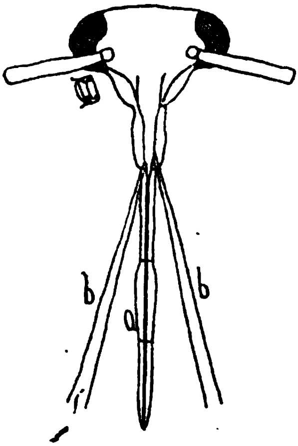


Fig. 3.—Head and Beak of Plant Bug.

We now see why it is that some other insecticide besides the arsenites must be used to kill these insects. They must be killed by bringing some substance in contact with them, and many of our remedies such as kerosene emulsion, hot water, carbolic acid emulsion, whale oil soap and pyrethrum are our only means of protection. The kerosene and carbolic emulsions are especially useful as they are very penetrating. All of this last list of remedies must come in direct contact with the insect to affect it, and this is one great reason why these remedies are so often reported a failure.

FUNGOUS DISEASES OF THE APPLE.

APPLE SCAB (*Fusicladium dendriticum*. Fckl.)

This is one of the most destructive diseases of the apple as it attacks both foliage and fruit, and, although it is more injurious to some varieties, and in some seasons, than others, it seldom fails to show itself to some extent. It is generally called "apple scab," but in some sections it is known as the "black spot" upon the fruit, and leaf blight and sometimes leaf mildew when upon the foliage.

It generally shows itself first upon the foliage as small, olive green, velvety spots. These enlarge and several may run together and thus involve a large portion of the leaf. Although most common upon the upper surface, they are often found, when the attack is severe, upon the under side, and may even extend to the leaf stem, and the young shoots. The tissues attacked are destroyed, and soon turn brown and dry up; when upon the leaf the discolored portion drops out, and in severe cases the entire leaf falls.

The greatest injury follows when the fungus shows early in the season upon the fruit, especially if the blossom stems are attacked. They are small and delicate, and a very small fungous spot will serve to girdle and destroy them. The spring of 1892 seemed to promise a large crop of apples, as the trees blossomed full, but heavy and continuous rains occurred while the fruit was in blossom, and not only caused an imperfect fertilization of the flowers and a failure to set, but, the conditions being favorable for the development of the apple-scab fungus, most of the others were so badly attacked that they soon dropped, or rotted upon the trees.

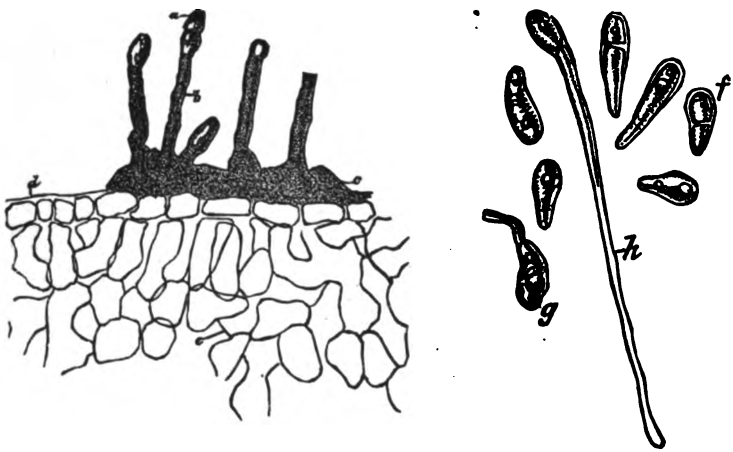


FIG. 4.

Fig. 4. Section through a scab spot. *a*, spore (conidium); *b*, hypha or supporting thread; *c*, mycelium, or plant body of fungus; *d*, epidermis of apple; *e*, cells of apple; *f*, spores greatly magnified; *g*, *h*, spores germinating.

When they first appear, the scab spots upon the fruit are about the same as upon the foliage, but, later on, the cells that have been destroyed take on a brownish-white appearance, while a dark-green circle surrounds them in which the fungus is still at work, and from which it constantly extends to the surrounding tissues, checking the growth of the affected parts, and often causing the fruit to crack. During hot, dry summers the fungus seems to rest, but if the season is moist the spread is rapid and the injury is often very great. It is estimated that in some States the loss ranges from one-sixth to one-fourth of the crop, often reaching a half-million dollars.

Not only is the development of the fruit stopped, if it is not prevented altogether, but the injury to the foliage is so great that the tree can neither develop the fruit it does set, nor form fruit buds for the next year's crop. The microscopical structure of this fungus is shown in Fig. 4.

In 1889 careful experiments with various fungicides were made and it was demonstrated that, with a comparatively small expense for labor and materials, nearly *ninety per cent* of the fruit *would be free from scab*,

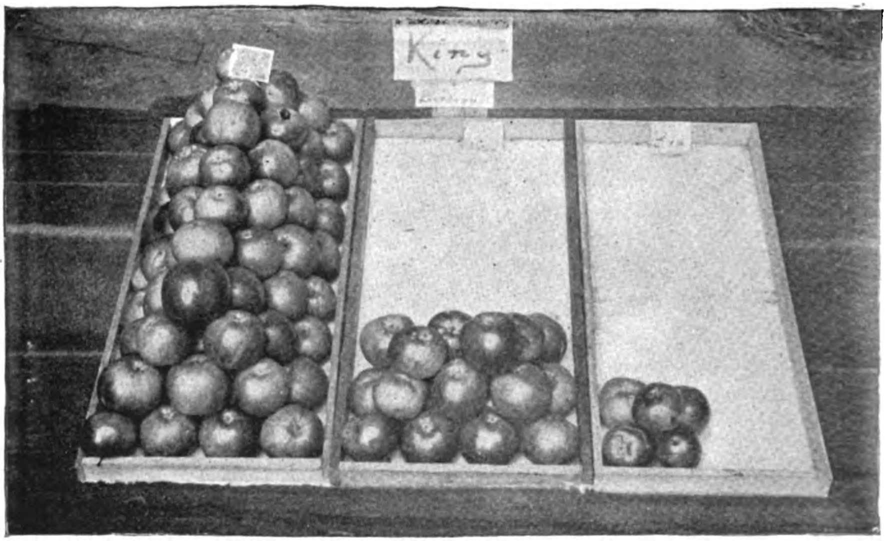


Fig. 5. Apples sprayed; 1, 2 and 3 show the grades of fruit obtained.

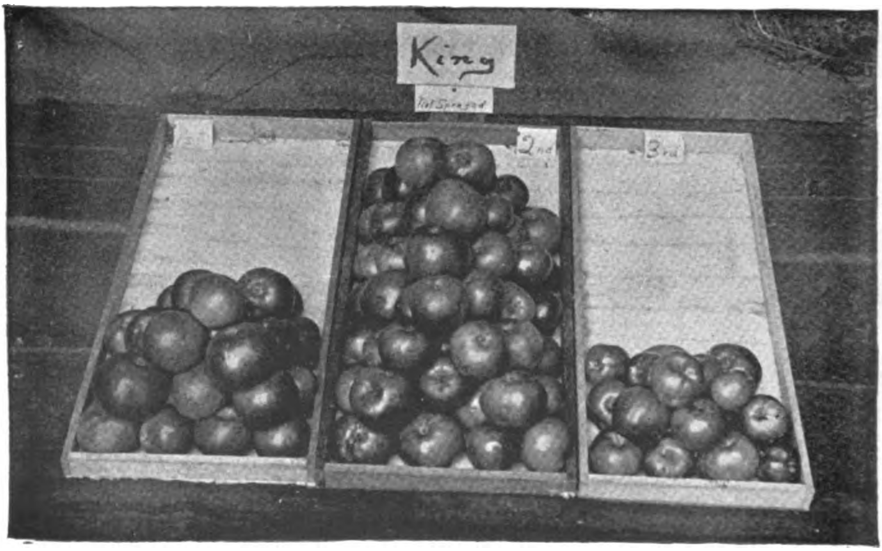


Fig. 6. Apples unsprayed. 1, 2, and 3 show the grades of fruit obtained.

while without the use of fungicides the proportion of scabby fruits was nearly as great. Had the spraying been commenced earlier, as we now know to be desirable, even better results would have been obtained.

The experiments conducted in 1893 by Prof. Lodeman of the Cornell Experiment Station, show conclusively that fungicides can be applied with profit to many varieties for apple-scab.

By the use of Bordeaux mixture and Paris green, the number of first-class apples was more than three times as great as when the trees were unsprayed, while the weight or measure of a given number of fruits showed that the spraying allowed them to attain a much larger size, and thus the total yield was considerably increased.

The illustrations show, in a very satisfactory manner, the results obtained by Prof. Lodeman, Fig. 5 being the relative number of first, second and third-grade fruits obtained from King trees sprayed six times with Bordeaux mixture, while Fig. 6 shows the number of fruits in the same grades from unsprayed trees.

As a treatment for the apple-scab, we would recommend that the trees be thoroughly sprayed with copper sulphate solution, before the growth starts in the spring. This should be repeated with Bordeaux mixture as soon as the blossoms have fallen. Especially if the season is a wet one, from two to three more applications will be necessary to produce the best results. The addition of Paris green to the second and third applications, will hold in check the codling-moth and canker-worm.

RIPE-ROT OR BITTER-ROT OF THE APPLES (*Glœosporium fructigenum*, Berk.).

The disease which has been commonly spoken of as bitter-rot from the unpleasant taste it gives the fruit, is also known as ripe-rot. The spots turn brown and, later on, the surface becomes dotted with black pimples. Like other fungi of the same genus, it can be held in check by the use of fungicides. Wherever the disease is troublesome it can only be guarded against by early and repeated applications, as, if the spores once gain entrance to a fruit, the spread of the disease through the tissues cannot be prevented. The treatment required for apple-scab will suffice for this disease, and no extra expense will be required.

BLACK-ROT (*Sphæropsis malorum*, Berk.).

While this disease resembles the ripe-rot in some respects, it differs in the fact that it often appears upon partially-grown fruit. The spots show as discolored, rotten specks, at any point on the surface of the fruit, but are most common near the stem. While they may be of small size when first seen, they often spread over the whole surface. The part first attacked soon becomes black in color and minute pustules make their appearance, and gradually extend over the diseased portions, rupturing the epidermis in concentric circles. The flesh beneath will be found moderately dry and of a brown color, with streaks or blotches of a darker color scattered through it. The spores are developed within the pustules upon stout stalks and are more broadly oblong in shape and larger than most spores. The mycelium of the fungus spreads through the tissues and destroys them.

So far as is known, there is no remedy that will prevent this disease, but the use of the copper compounds will certainly lessen the injury. The diseased fruit should also be destroyed.

APPLE-RUST (*Gymnosporangium macropus*, Lk.).

This at times proves quite troublesome upon the foliage. It is believed that one stage of this disease is passed in the so-called cedar-apples of the red cedar and that the orange-colored spores of that fungus can convey the disease to the foliage of our apple-trees. As a preventive the red cedar-trees near apple orchards should be destroyed, if the disease is troublesome.

Although there have been no experiments that prove the fungicides to be effectual against this disease, it is not likely that the spores can gain entrance if the leaves of our apple trees are kept well covered with Bordeaux mixture, as is desirable against the other diseases.

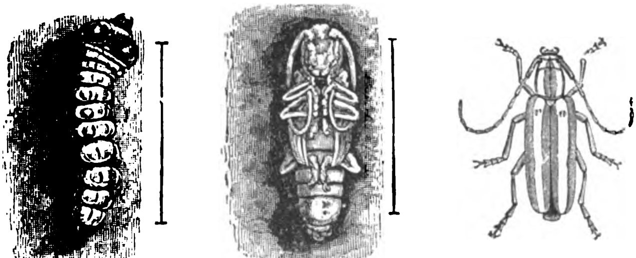
In addition to the above diseases the following are sometimes troublesome:

Twig Blight (*Bacillus amylovorus*, Burr.), which is similar to the fire blight of the pear, but seldom spreads over the trees; Powdery Mildew (*Podosphæra oxycanthæ* (D. C.), De By.), which is most injurious to seedlings in the nursery, but sometimes is troublesome upon orchard trees. It is quite similar in structure to the powdery mildews of the cherry and gooseberry, and the copper compounds will control it; Leaf Spot (*Phyllosticta pirina*, Sacc.) is also given as injurious to the foliage and Fruit Spot (*Phyllachora pomigena* (Schw.), Sacc.) which has been noted in some sections upon the fruit.

INSECTS OF THE APPLE

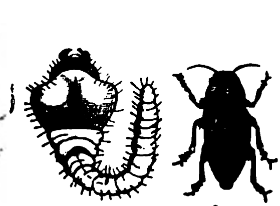
BORERS IN THE TRUNK AND BRANCHES.

There are quite a numbers of borers that burrow in the trunk and branches of the apple tree. The more common are the Round-headed Borer (fig. 7) and the Flat headed Borer (fig. 8). The former is said to live three years in the wood as a grub and to bore in perfectly green wood. Consequently each grub of this species is more destructive than those of the flat headed borer, which are usually more numerous, but live only one year in the tree as a borer and prefer sickly or newly planted trees for their attack. The imago of both borers, deposits its eggs in June and early July, on the bark of the trees, usually in crevices or under rough, loose pieces, near the ground, but sometimes on the smooth bark of the limbs.



a b c

Fig. 8.—Round headed Apple Tree Borer, *Saperda candida*, a, larva; b, pupa; c, beetle.



a b

Fig. 7.—Flat Headed Apple Tree Borer, *Chrysobothris femorata* Fabr. a, larva; b, beetle.

Remedy.—Borers are a difficult class of insects to deal with, as digging them out after they have entered a tree is a treatment too severe to be practiced if it can be avoided. The best success is found in the use of a repellant, or some form of a mechanical coating at the time the eggs are laid. The *carbolic acid and soft soap wash* and *arsenated lime as a paste or whitewash* are the two most likely to give satisfactory results. Whichever is used, the application should be made early in June and a second three weeks or a month later, first clearing off the rough, loose bark.

In applying either of these remedies, a scrub brush does the best work in covering the bark, as it pushes the material into the crevices where the borer usually deposits the eggs.

THE OYSTER-SHELL BARK LOUSE (*Mytilaspis pomorum* Bon.).

Very few orchards in Michigan are free from this pernicious little sap sucking scale. While it is attached to the bark, all that we see of the louse is the minute scale-like covering which it secretes over itself. Upon lifting the scale, the louse or its eggs can be seen by the aid of a lens. From fifteen to one hundred eggs remain over winter under each scale. In May or early June, these eggs hatch into minute yellow lice that soon leave the shell and enjoy a life of freedom for a few days, when they become permanently located, insert their beak for the sap on which they feed, and soon begin to secret a shell of wax over themselves, never to leave it again. By August the female has filled her shell with eggs and dies, the eggs remaining in the shell over winter.

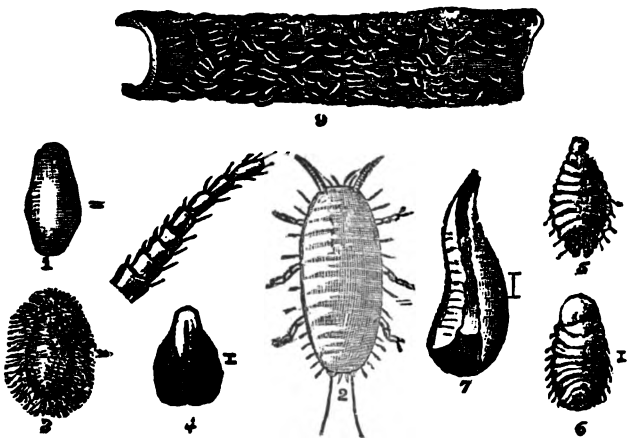


Fig. 9.—Oyster-shell Bark Louse; *2*, young louse magnified; *3*, secreting wax covering; *5* and *6*, louse without scale; *7*, louse in scale, underside; *9*, scales on bark, natural size.

Remedy.—Scrub the trees with *carbolic acid and soap mixture* in the spring or spray with *kerosene emulsion* in May when the young lice are running.

CANKER WORMS.

Apparently the worst insect of the apple orchards for the past few years has been the canker worm. Many people have found the leaves in the orchard turning brown and disappearing almost as soon as the trees are through blossoming. This is the work of canker worms. If one of the limbs is jarred as soon as the work is noticed, many looping caterpillars, such as are seen in the cut, will often suspend themselves in mid air, or drop to the ground by a thread which they spin. These Geometers, or measuring worms, enter life from the egg at the time the leaf is unfolding and develop very rapidly. They eat but little while small, and for this reason their work is not noticed until they are nearly grown, when they are ravenous feeders. They very soon leave the tree and enter the ground to change to a moth that will lay eggs for the next year's generation. Part of these moths appear late in the fall, and lay their eggs, but the greater share of them wait until the following spring. The female is wingless, and must crawl up the tree to deposit her eggs. Many have taken advantage of this peculiarity and placed tarred bands around the trunks, or tin collars, sloping so that she cannot crawl over them, and thus prevent egg-laying. Bands of wool, such as are used for climbing cut worms, will probably serve the purpose even better, as it will not mat or harden with moisture. It should be made tight to the trunk, but left loose outside.

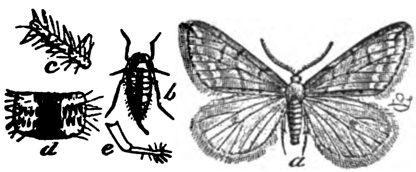


Fig. 10 A.—Canker worm. *a*, male moth; *b*. female moth.

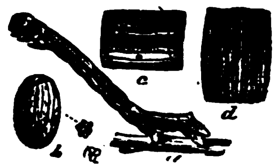


Fig. 10 B.—Canker worm. *a*, larval, natural size; *b*, eggs natural size and enlarged.

Remedy.—The means of prevention just given are very good ones, but if the trees are given a thorough spraying with Paris green at the first notice of the canker worms, there need be little trouble in controling them. By a careful search on the young leaves near the ends of the twigs, the small, slender, dark brown loopers may be found before the trees blossom. They are then young and have done comparatively little harm. This is the time when spraying is a success. Where so many fail with spraying is in waiting too long before applying the remedy. One may be almost certain of finding the canker worms the second year if they have appeared in an orchard.

CLIMBING CUT WORMS.

In the fruit belt along the shore of Lake Michigan and on sandy soil in other parts of the State, climbing cut worms are frequently the most dreaded of the orchard pests. They appear early in the spring while the leaf buds are opening and come in such great numbers that, if one is not prepared to stop their work at once, they denude whole orchards in a few days' time. The cut worms hide in the ground near the surface during the day, and are found in the trees only at night, when they feed. They climb straight to the top and leave the lower limbs until the last, so that

they make the upper part appear dead, while the lower part will be in blossom. Where the buds are eaten, the fruit and much of the foliage is destroyed for the season and sometimes the trees are killed.

There are several species of cut worms that have this habit of climbing trees and feeding on the buds. A figure of one of these in three of its different stages will give an idea of the appearance of all of them. When a cut worm is full grown it measures from an inch to an inch and three-quarters in length and is very plump. It then ceases feeding, buries itself in the ground and transforms to a pupa as is shown at Fig. 11, *c*. In this quiet stage it remains until July or August, sometimes until the following spring, when it hatches out into a dingy moth, resembling closely the one shown at *b*. The moth does not eat as the caterpillar did, but merely sups sweets from the flowers at night, resting in some secluded place, as did the cut worm by day. At this time the moths mate and the female soon lays a number of eggs, perhaps from 50 to 200, and then, as her mission is done, she soon dies. The eggs are deposited somewhere near the trees, or on the leaves, so that when the young cut worms hatch in the early spring, they will not have to go far to secure a good supply of food. The young cut worms grow rapidly and soon are matured to again go through the same cycle of life that their ancestors did.

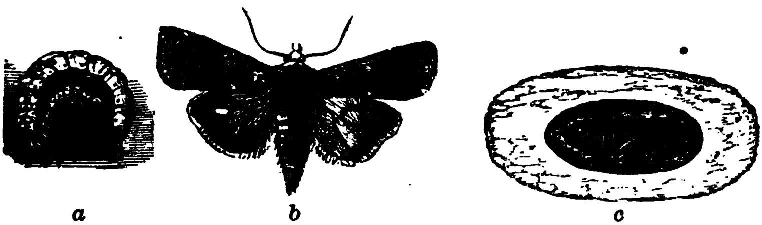


Fig. 11.—Climbing Cut Worm; *a*, larva; *b*, moth; *c*, pupa.

Remedies.—Fruit growers in the regions where the climbing cut worms are most troublesome find good protection in the use of a wool band tied around the trunk of the tree. The band should be four or five feet from the ground and tied in such a manner that it will be tight to the trunk, that the cut worms can not crawl under, and left loose and fluffy on the outside so that they can not crawl over. It should be placed on the tree early in the spring before the cut worms make their appearance. Wool will not pack with rain and dew like cotton and similar material.

The only fault found with such a band is that, when the caterpillars can not crawl over the band, they soon become hungry enough to gnaw into the bark beneath the band and so kill or injure the tree. To obviate this Judge Russell of Oceana county, has suggested standing small limbs, wet with a strong solution of one of the arsenites, in the ground under the trees close to the trunk. The cut worms will climb into these limbs in preference to the taller trees and will be killed by the poison. By the use of both bands and poisoned branches one should be able to protect the trees against the worst attacks.

THE TENT CATERPILLAR (*Clisiocampa americana* Harr.).

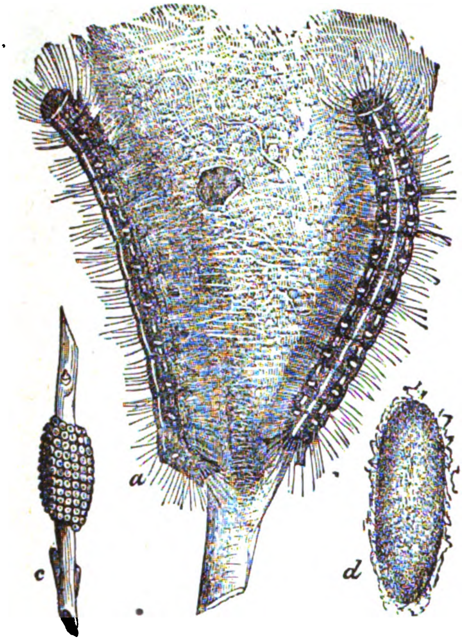


Fig. 12.—Tent Caterpillar; *a* and *b*, caterpillars; *c* and *e*, egg clusters; *d*, cocoon.

The tent in the crotch of some limb, with the caterpillar inhabiting it, is too well known to need much description. The thick, closely woven web, so common in May and June, protects the caterpillars from their foes, except at regular intervals when they leave their tent long enough to feed on the leaves outside, until they reach maturity. If the trees are neglected, large portions are entirely

Fig. 13.—Tent Caterpillar moth.

stripped of leaves by these tent dwellers. When about an inch and three-fourths long, the caterpillars leave the tent and scatter in all directions for suitable places to transform to the imago, which is a handsome reddish-brown moth (Fig. 13). This moth in early autumn lays a cluster of two hundred or three hundred eggs in a circle around a twig and covers them with a glue-like secretion that protects them until they hatch the following spring.

Remedies.—Cut out and burn in a little kerosene or else crush them while in the tree. They may also be killed with the arsenites if thought best to spray the trees for them. In spraying for the canker worms, the tent caterpillar will be poisoned by the same application. When the egg clusters are found, they should always be destroyed.

BUD MOTHS.

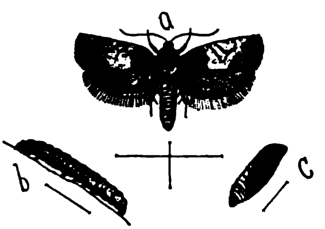


Fig. 14—Apple Tree Bud Moth, *Tmetocera ocellana*; *a*, moth; *b*, larva; *c*, pupa.

Early in the spring minute caterpillars often appear in large numbers to feed on the buds as they are unfolding. One small caterpillar can do a great deal of injury to the leaves at this time, if it does not entirely destroy them while still in the bud. Spraying with the arsenites at the same time that spraying is done for the canker worms and a little before the time of the codling moth, will be the best protection.

THE CODLING MOTH OR APPLE WORM (*Carpocapsa pomonella* Linn).

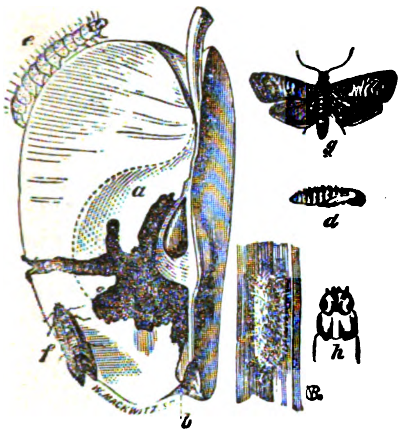


Fig. 15. Codling moth; *c*, larva; *d*, pupa; *i*, cocoon; *g* and *f*, moths.

This caterpillar still remains a common and destructive pest to the apple, though one of the easiest to control by spraying the orchards. As long as spraying is neglected, not much fruit that is marketable or fit to keep can be expected. The accompanying cut explains all the different stages and work of the moth. There are two broods each year, but if the trees are given a good spraying with one of the arsenites within ten days after the blossoms fall from the trees, if there is no rain for a few days severe enough to wash the poison off, it will generally suffice for the season. If the first brood is nearly all killed the second brood will do little harm. If very heavy rains follow almost immediately after the first spraying, a second application, a little later, may be necessary.

THE WHITE TUFTED CATERPILLAR (*Orgia leucostigma*) and THE RED HUMPED CATERPILLAR (*Œdimasia concinna*).

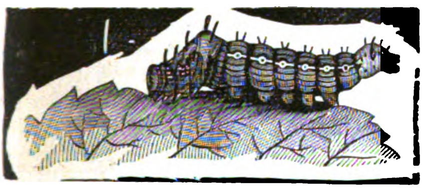


Fig. 16.—Red Humped Caterpillar.

These are so named from the appearance of the respective caterpillars. They are very frequently met with on the apple in numbers that strip the leaves from parts of the orchards and sometimes injure the foliage in whole districts. A good spray of Paris green is the best remedy for them, as well as for a large number of less injurious leaf-eating caterpillars.

APPLE TREE APHIS (*Aphis mali*, Fabr.).

In the spring and early summer these little, green, wingless lice are often found in great numbers over the buds and leaves. Through their minute beaks they take much of the sap that is needed for the life and growth of the tree. They multiply very fast and should be destroyed, if they are numerous, early in the season.

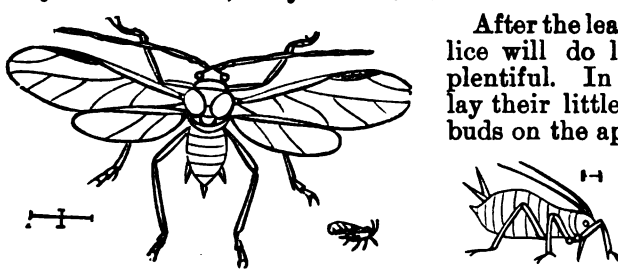


Fig. 17.—Apple tree aphis, winged and wingless forms.

After the leaves have developed, the lice will do little harm unless very plentiful. In the fall the winged lice lay their little, black eggs around the buds on the apple twigs. These eggs hatch into the small, green lice when spring opens.

Remedy.—Kerosene emulsion as early as the lice are seen in the spring.

GENERAL CARE OF AN ORCHARD TO PROTECT AGAINST INSECT ATTACKS.

Much that has not been given on the preceding pages can be done in protecting an apple orchard against insect depredations of all kinds. It all comes under good care and management of an orchard.

1. An apple orchard that has had all dead or diseased limbs and trees cut out and burned each season, will seldom be troubled with any kind of borers. Brush piles and dead wood of all kinds in an orchard, breed borers very fast and, as soon as there is no dead wood, they will attack that which is living.

2. Cultivating an orchard will greatly lessen the number of leaf eating caterpillars and bud moths that annually appear. Many of them pupate in the dead grass and stubble and when these are not present, other insects and birds are quite apt to find them and eat them.

3. If the stock could have all the windfalls and wormy apples each season there would be fewer worm eaten apples than we now have; and, were orchardists united in doing this, there would be no need of spraying for the codling moth.

In general we may say, keep the orchard clean and free from dead or diseased wood, and rubbish of all kinds. Protect against climbing cut worms by wool bands in early spring. Keep watch when the leaves begin to open, and if the young canker worms are present, spray the trees with one of the arsenites. In a week or ten days after the blossoms fall, spray the orchard for the codling moth, and if the wormy apples, that may have escaped the spraying, are fed to the stock, so much the better. A tree to be kept in a thrifty condition, should not suffer constant sap drainage from bark and leaf lice and should be protected against them when they are numerous. Occasionally other insect outbreaks may appear in a well kept orchard, but usually, if we take care of these five or six, the other one hundred and ninety will never cause any anxiety.

DISEASES OF THE PEACH.

PEACH YELLOWS.

Although nothing is known as to the cause of this most to be dreaded disease of the peach, it has been carefully studied for years and the effect of the disease and the treatment are understood by most fruit growers. As an indication of the virulence of the disease, it may be stated that, so far as it is known, no tree in the State of Michigan, that has been attacked by the yellows, ever recovered from it. The disease has appeared under almost all conditions, and none of them can be cited as the cause. While it is probable that a tree, grown under conditions that are in every way favorable, will be less subject to attack than one that is feeble and exhausted, either from lack of proper food or from overbearing, the tree that is appar-

ently the healthiest may not escape. Excellent illustrations of this disease are shown in Bulletin 103 and in the report of the State Board of Agriculture for 1894.

The disease first shows itself, in bearing trees, in the premature ripening of the fruit; this, with the spotting and streaking of the skin and the flesh of the fruit is generally a sure sign of the yellows. Owing to this spotting, the fruit takes on a high color, and the flesh is also a dark red, although the discoloration may be confined to threads that run from the stone in all directions to the surface.

A tree that has reached this stage should be condemned, and the law requires that fruit, with the above described markings, shall be destroyed. Although at first the taste is not unpleasant, in the advanced stages it becomes quite bitter.

The second stage of the disease, or the first in trees that are not bearing, is shown by the sending out of small wiry twigs either from the young shoots or from the axils of the larger branches. The new shoots take on a bushy appearance from the fact that the buds which should send out shoots the following year, prematurely develop weak spindling branches. Not only may these weak shoots from the winter buds appear, but wiry growths may appear at any time and at any place, although they are most likely to start near a crotch.

The leaves will be small and more or less clustered so that they may have a rosette-like appearance; they also generally take on an unhealthy yellowish look, particularly late in the season and during the following year. Many of the branches will probably die during the second winter and few of the trees will survive the third.

The disease is unquestionably contagious and the only hope of saving an orchard once attacked is in cutting out the diseased trees as soon as the first symptoms are seen. It is not known how early in the development of the disease it takes on its contagious nature, but caution would certainly dictate that they be taken out as soon as the first indication of the disease shows itself, particularly as there is no hope of saving the tree. Many careful observers believe that the disease can be communicated by rubbing a branch of a diseased tree against a healthy one. If this is the case, we cannot urge too much caution in the removal of the trees and many make use of the plan of cutting up the trees and burning them on the spot. It will always be safest to so dig out the trees that the trunk and the larger roots will be removed.

While nothing is known as to the length of time that should elapse before the vacancy can be filled with safety, many peach growers replant the spring following the taking out of the trees.

The so called "Yellows" law is intended to protect fruit growers against their careless neighbors who may from ignorance or shiftlessness neglect to remove and burn their diseased trees. This law was printed in Bulletin 103 and in the report of the State Board of Agriculture for 1894.

PEACH-LEAF CURL (*Exoascus deformans* [Berk.], Fckl.).

Although the appearance of this disease is familiar to all peach growers, the nature of the trouble is not generally understood. Sometimes the leaves of the peach, and more often those of the cherry and plum, are infested with plant lice (aphides), and become blistered and curled so that they look much the same as when attacked by the true "curl."

In cases when the attack is a severe one, the foliage may nearly all fall to the ground, and as a result most, if not all, of the fruit drops. Although other leaves will be put out, the check to the tree is a severe one and, in the case of young trees, great harm is often done; bearing trees may be so weakened that they may not develop fruit buds for the next year's crop, while those that are formed will be so weak that they are likely to be killed, even in a mild winter. Particularly upon young trees, the disease may also attack the tender shoots and they will be killed back by it.

The "curl" is most troublesome in seasons when the weather, during the two or three weeks following the putting out of the leaves, is cold and wet. After the disease has run its course, and new leaves have come out, there is seldom any further attack, provided the weather comes off warm. The diseased leaves become considerably swollen and blistered and, as it is generally more or less irregular, they are often considerably curled and twisted. The swelling is caused by the working of the mycelium of a fungus within the tissues and in a few days the upper surface will take on a mealy appearance, owing to the development of the innumerable crop of spores.

The spores remain in the branches and fallen leaves during the remainder of the year and, as soon as the new foliage appears in the spring, are at hand to spread the disease. While the tissues are still soft, they can readily penetrate the epidermis, but, it would seem that after they become firm, there is no further danger, although any new leaves that appear will be subject to contagion.

To secure good results from any treatment, it is well to head back the branches in the spring, carefully removing any that were injured by the "curl" the previous year, lest the mycelium of the fungus might remain in the issues and spread to the new leaves when they appear.

Our experience for two years goes to show that, when the trees have been properly pruned and are in good condition, the disease can be held in check if they are sprayed with Bordeaux mixture, making the first application just before the buds open and repeating it as soon as the trees are out of bloom and again at the end of ten days or two weeks.

With each application, Paris green should be used for the curculio. Our own experiments in several places in the State, seem to indicate the value of the above treatment, and the fruit growers who have made use of the remedy are well pleased with it, in nearly all cases. It is likely that where failures occurred, some of the conditions noted for success were not furnished.

If the disease is in the tissues from the previous year, or if the new leaves were left for a number of days uncovered with the copper compound, the germs could readily enter the tissues of the leaves and no later sprayings would save the leaves attacked, although they would prevent the spread to others.

BROWN ROT (*Oidium fructigena*, Kze. and Schm.).

The peach is also seriously injured by this disease, of which a description will be found under the diseases of the cherry. From the fact that the conditions for the development of the disease are particularly favorable at about the time their fruit begins to ripen, the early varieties seem to be particularly susceptible to the attack of this disease. The germination and work of this fungus is so rapid that frequent applications of fungicides are

necessary to hold it in check, especially as the June showers, in which the disease seems to revel, are unfavorable to the highest success, through the washing off of the fungicide.

BROWN SPOT (*Cladosporium carpophilum*, Thüm.).

This often does considerable injury to peaches, particularly to small, seedling varieties. It shows upon the fruit as brown, velvety spots and, if these are very numerous, they will run together and form patches of considerable size. When thus attacked, the fruits fail to reach their normal size and are often rendered of no value for market. While the efficacy of fungicides for this disease is not known, it is believed that they will lessen the injury. At any rate there will be no extra cost for the application, as it will be required for the rot and other diseases. This disease has also been noticed upon Russian apricots, where the injury is even more severe than upon the peach.

Another disease, the exact nature of which has not been ascertained, but which is well described by the common name of "pimples," is also found upon the fruit, particularly of seedlings and the Wager variety. It appears as small swellings, or pustules, and as they are sometimes quite numerous, they often seriously injure the appearance of the fruit. The spots are surrounded by a dark purple ring, and the center, particularly of the older spots, is white. This disease does not appear until about the time the fruit ripens and nothing is certainly known as to the effect of fungicides upon it. It may become a troublesome disease.

The "Shot-Hole Disease" which is described under the plum and cherry, also attacks the leaves of the peach, causing small holes to appear, owing to the destruction and dropping out of the tissues. It seem to be most troublesome on damp soils and in wet seasons, but the treatment recommended for the leaf-curl and the rot seems to lessen the injury.

INSECTS OF THE PEACH.

THE PEACH TREE BORER (*Sannina exitiosa*, Say).

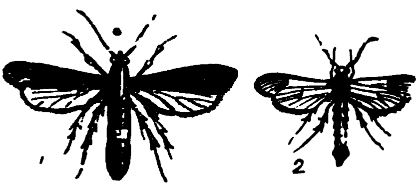


Fig. 18.—Moths of Peach Tree Borer: 1, female; 2, male.

Each peach grower must make the acquaintance of this unmitigated pest very early in his work and devise some means of protection to his trees or the borers will, in a few seasons, assume control. The yellowish white borers, with their black jaws, reddish brown head and eight pairs of legs are too well known to need further description, but the imagos, to which they change (Fig. 18), are rarely seen. The male and female differ somewhat in color and size, but they are both beautiful day-flying moths that are lovers of sunshine and heat. There is but a single brood each season, yet that brood is so irregular that in cutting out the borers there will be a great variety in size, and the moths are present all through the summer, being the most common through July. Soon after appearing, the female begins to deposit eggs, one in a place

near the roots, though sometimes higher up on the trunk, even to where the branches start. When the eggs hatch, the young borers gnaw their way through the bark. They then follow the bark closely, cutting long channels as they go, usually toward the roots, but sometimes in other directions. Here they remain until they attain their full growth the following season, when they construct a cocoon of chips in the burrow and transform to a pupa and a little later to the imago.

Remedies.—The exudation of gum from the wound made by the borer in entering is a strong indication of its presence, and borings outside the opening is a sure indication. The general practice is to make use of these signs of the borer and go through the orchard in the fall and spring, and with a knife dig the borers out. While this method prevents the borer from doing its greatest injury to the tree, the cutting-out system has little to recommend itself beyond this. Very often the injury made with the knife is as great as that made by the borer and will never heal over. All cutting and boring is more or less injurious to a tree. What we must seek for is some method by which the borer will be prevented from entering the bark, or for preventing the moth from laying her eggs. The best preventive that we can recommend now is a whitewash made of lime to which has been added enough Paris green to give it just a slight, greenish tinge. When the young grub hatches and attempts to gnaw through the bark, it will eat enough of the poison to kill it before it enters. The unsatisfactory feature about this method is that the whitewash has to be replenished once or twice through the season, as repeated rains will wash it off. We are just in receipt of a remedy known as "Caterpillar Lime," that we hope will obviate this difficulty. It comes highly recommended for such purposes by fruit growers in Germany, and we shall give it a thorough trial. If it proves as recommended, it will be our best remedy for the peach tree borer. The preparation is sold by Wm. Menzel & Son, 64 Broad St., New York.

THE PEACH TWIG MOTH (*Anarsia lineatella*, Zell.).

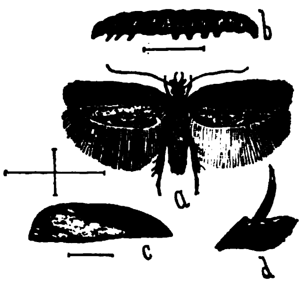


Fig. 19.—Peach Twig Moth: *a*, moth; *b*, caterpillar; *c*, pupa.

The second most injurious insect, in most peach orchards, is the peach twig moth, *Anarsia lineatella*. The young caterpillar begins feeding at a terminal bud of a peach twig, and after, eating the bud, bores into the twig along the pith, sometimes to the length of an inch and a half or two inches. Then it will leave that twig and repeat the same process on others until it attains its growth. A few caterpillars will thus destroy quite a number of twigs in a short time, and when the caterpillars are numerous, as they are some seasons, quite a per cent of the twigs will be dead at their tips. The little caterpillars appear very early in the spring at about the time the buds start and continue their work for some time after the leaves attain their full size. When full grown the caterpillars are only about one-third of an inch long. In color they vary from a reddish to a dusky brown, with the head and thoracic shield varying from yellowish brown to black. They have eight pairs of legs as represented in *b* of the figure and are naked excepting a few scattering hairs. The caterpillars usually pupate in the dead leaves at the end of the twig

on which they worked last, and issue some time in June from the pupa stage as a moth. The second brood of the caterpillars appears in August and, according to Professors Cook and Comstock, specimens of this brood have been found feeding in the peaches instead of the twigs. Nor does the species confine itself to the peach alone. It has been known to attack the twigs of the plum and, perhaps, the apple in the same way. It has also been reported as a strawberry root and crown borer, destroying many of the plants.

Remedy.—The surest way of disposing of these twig borers is by cutting off the ends of the twigs containing the caterpillars and burning them. The injured shoots can be easily detected by the dead buds and leaves and by exuding gum and similar signs. If the trees are sprayed with one of the arsenites, as the buds are opening, many of the caterpillars will be killed while eating into the twig. The arsenites should never be applied unless lime or Bordeaux mixture is used with them, as the foliage of the peach is tender and liable to injury. With lime, the arsenites are harmless to the foliage.

THE ROSE CHAFER (*Macrodactylus subspinosus*, Fabr.).


Fig. 20.

In sandy regions and on sand ridges, this beetle is a pest on the rose, grape, peach, apple and many kindred plants. The beetles appear about the time roses and grapes are in blossom, and none need mistake the awkward, long-legged beetles with a dusty yellow body about one-third of an inch long. The chafers breed in the ground, feeding on the roots of various plants, particularly grass, and live in this condition almost the entire period of their life. The imago is above ground only two or three weeks, so it is not the length of time that makes them such dreaded pests, but it is in the countless numbers that swarm on the plants and oftentimes fill the air. It is at such times that calls come for help, but with all our remedies we are as helpless as anyone. The arsenites will kill them and so will kerosene emulsion, and hot water at from 130 to 165 degrees, Fahr., but none of these are practical where the chafers come in swarms. They are constantly traveling and, in a few minutes after treatment with hot water or kerosene emulsion there are as many new arrivals as there were individuals feeding on the plant before. In the peach orchard they appear about the time the peach is a third or half grown. The fruit is the first thing they attack. As it is so fuzzy they eat only a small hole in the skin and then as many as can will enter this hole and eat on the inside of the peach. This habit makes them still more difficult to treat, though for most plants and fruits attacked by them we may say that, where not too numerous, either the hot water or kerosene emulsion when persistently used will prove satisfactory. Beyond this we must look largely to preventive measures, for here is the key to our success. The beetles breed almost exclusively in sandy places and if we can keep these ridges in our vicinity under cultivation, the rose chafer will never appear in numbers great enough to do any serious damage to our crops or fruits.

PLANT LICE ON PEACH TREES.

There are two species of plant lice that work on the peach. The black aphis (*Aphis persicæ-niger* Smith) which lives under ground on the roots and also on the leaves and tender twigs; and the common leaf aphis (*Aphis*

persicæ Sulzer) a brownish or yellowish aphis that feeds on the leaves and causes them to curl, a little later in the season. There is a plant disease, known as leaf curl, that produces a similar effect on the leaves. If on examining some curled and knotted leaves, no plant lice are found, one may be quite sure that the formation is not due to the aphids, but to the plant disease. The habits of these lice are the same as those found on the apple, cherry and plum. They are wingless at first, but, later in the season, both forms will be found. After they hatch from the egg in the spring they produce living young, multiplying very fast, and do a great deal of harm when numerous.

Remedies.—Kerosene emulsion is the best remedy for the lice on the leaves and tender twigs. The remedy should be applied if possible before the leaves curl as it will be hard to reach them with any remedy when they are protected by the leaf.

The work of the lice on the roots is usually shown in the tree having a sickly and unthrifty appearance, and it is said that one might mistake the appearance for peach yellows. An unhealthy condition of a tree is not necessarily due to the root louse. If the soil is partly dug away from the roots and a few pounds of kainit sprinkled near the roots and the whole covered, the application will benefit the tree. Kainit is a fertilizer, and will also kill the subterranean lice if there are any.

DISEASES OF THE PEAR.

PEAR BLIGHT (*Bacillus amylovorus*, Burrill).

The disease of this fruit that is the most to be feared, is the one that is commonly called "fire blight" or "frozen sap blight." It is really caused by the development within the tissues, of the germs of a minute bacterium, which produces a sort of fermentation in the sap of the trees. They gain entrance through the nectaries and the stigmas of the flowers, through the soft tissues of the young leaves and stems, and through cracks in the bark. The old name of "frozen sap blight" indicates that fruit growers have keen powers of observation, as the freezing and thawing of the unripened wood causes the bark to crack, and the germs are often thus admitteed to the tissues of the trunk and older branches. The name of "fire blight" both describes the appearance of the disease and applies well to cases where the bark is cracked by the drying influence of the sun in seasons of drought.

It has been noticed that trees which have grown slowly and have firm, well-ripened shoots are less subject to blight than others that make a watery growth and expose for a long time their soft shoots to the entrance of the germs. Once inside, the germs multiply with great rapidity and spread through the tree, but at a slower rate than is usually supposed. The germs are conveyed from diseased trees to the healthy ones by insects, which visit the flowers for the purpose of obtaining nectar, and the germs then enter through the nectaries or stigmas and such other parts as may favor their entrance. Although we have no direct evidence of the fact, it is evident that they also are carried in the air and thus enter the leaves and the cracks in the bark.

Pear blight causes the leaves to turn a dark brown and may manifest itself suddenly through the entire tree, although as a rule only a single branch is affected at the start, depending upon the way in which the germs have entered.

The fermentation that ensues causes the bark to crack and a thick, gummy sap with a disagreeable odor exudes; the bark soon becomes dry, and if the affection extends entirely around the stem, the entire branch soon takes the characteristic appearance of blight. The leaves dry up and remain attached to the stems for a considerable length of time.

If the disease enters through the blossoms, the flowers and fruit spurs are first attacked and turn brown, after which the disease spreads along the branches.

While the germs could undoubtedly be destroyed, if all parts of the trees could at all times be kept covered with Bordeaux mixture, or some other fungicide, this is impossible with the nectaries and to some extent with the young leaves and the cracks in the bark. While the sprayings that should be given the pear trees to destroy the other fungi will aid in holding the blight in check, it will not entirely prevent it.

As a further means of prevention, various precautions can be taken that will do much to lessen the liability of the trees to be attacked by the blight, and among them are the following: 1. Select varieties that have small, firm twigs, and that ripen their growth soon after it forms; 2. While the pear needs a deep, strong soil, care should be taken not to use one that is unduly rich in organic matter, as it would be likely to cause a rank growth that would admit the germs, either through the tissues or the punctures made by the insects, or a late growth that would be injured by the winter; 3. Avoid the use of excessive quantities of undecomposed manure, which will also cause a rank growth. The principal dependence should be placed upon mineral manures; 4. In case the trees are making too rapid a growth, the orchard may be seeded down for a year or so.

In case the pear blight makes its appearance in a tree, the diseased branch should at once be cut out, making the excision a foot or so below where any signs of the blight appear on the outside, and if the cut surface seems discolored, a cut still lower down should be made. While this may not in all cases prevent the reappearance of the blight there is nothing else known that will aid in the matter.

PEAR LEAF BLIGHT (*Entomosporium maculatum*, Lev.).

This disease is particularly destructive to seedling trees in the nursery and to those that have borne large crops of fruit in seasons of severe drouth. It is known that it is of fungous origin, and remedies have been found that will hold it in subjection if they do not prevent it altogether.

It first shows itself on the leaves as small, brown spots, which soon coalesce if sufficiently numerous, and thus form spots of considerable extent.

Later in the season, small, black spots appear upon the brown patches, which are composed of great numbers of spores. When the conditions are favorable for the development of the disease, it spreads with great rapidity and so injures the foliage that all of the leaves sometimes fall, leaving the tree in its denuded condition, unable to ripen its wood. The same disease often appears upon the fruit, where it is known as the

"cracking of the pear." If the spots are sufficiently numerous, the growth of the affected parts is checked and a crack is formed. With some varieties the injury is so severe that, before fungicides came into use, it was not possible to obtain marketable specimens from them.

When the disease attacks young pear seedlings in the nursery, it is also very troublesome, as it stops their growth and renders budding uncertain.

It has been found that the leaf blight can be readily held in check by the use of the copper compounds, and that if the trees are sprayed with Bordeaux mixture at intervals of about two weeks, up to the middle of August, there will be little if any injury from it.

PEAR SCAB.

The leaves and the fruit of the pear are sometimes attacked by this disease, which is considered identical with that of the apple (*Fusicladium dendriticum*). The principal damage is upon the fruit, and in some cases it is quite severe, but the applications of the fungicides have been found to give fruit nearly or quite free from it.

INSECTS OF THE PEAR.

PEAR TREE SLUG (*Eriocampa cerasi*, Peck).

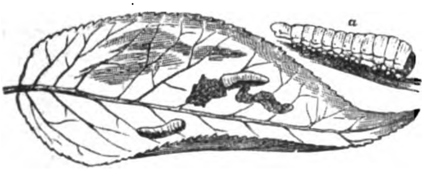


Fig. 21.—Pear tree slug, various sizes.

This is the most common and the worst insect enemy of the pear tree. It is quite as common on the cherry and is often found on quince, plum and similar trees. The parent fly of the slug is jet black and when seen on a leaf, might be taken for a house fly except that it is smaller. It is called a saw fly as the female has a saw at the tip of the abdomen that she uses to puncture the leaf in which to lay an egg. The eggs soon hatch into slimy slugs that eat the tender portion of the leaves and cause them later to appear dead. There are two broods, the first one coming early in June and the second late in July or August. The first brood is the one that does the harm, as the tree needs all its leafy growth in the early part of the season.

Fig 22.—Saw fly.

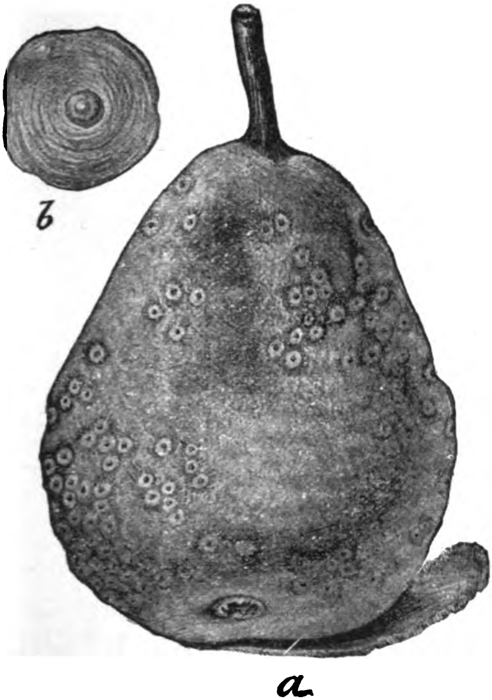
Remedies.—Spray with the arsenites or hellebore, or dust the trees with air slaked lime, plaster, road dust or ashes. The slugs are very easily killed by any of these and if the first brood is destroyed *there is no danger* of the second.

Many of the insects that attack the apple, plum and cherry, also work more or less on the pear, such as the oyster shell bark louse, the borers, coddling moth, plum curculio and many of the caterpillars.

THE SAN JOSE SCALE (*Aspidiotus perniciosus*, Comstock).

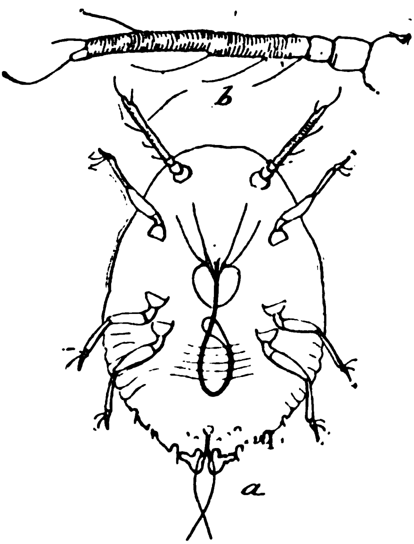
Ten years ago this pernicious scale was not known east of the Rocky Mountains. Since that time colonies have been found in Virginia, Florida, Maryland, New Jersey, Pennsylvania, New York, Canada, Ohio and Mis-
-. and no doubt, as the scale becomes better known, colonies will be

PLATE I.

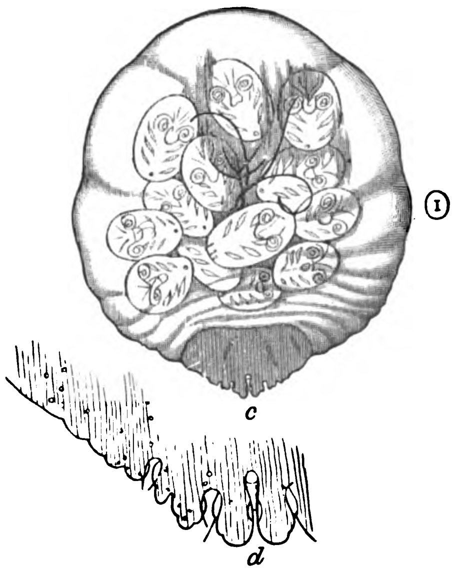


San José Scale.—*a* California pear, moderately infested—natural size; *b* female scale—enlarged.

San José Scale.—Apple branch with scales *in situ*—natural size; enlarged scales above, at left.



San José Scale.—*a* Young larva—greatly enlarged; *b* antennæ of same—still more enlarged.

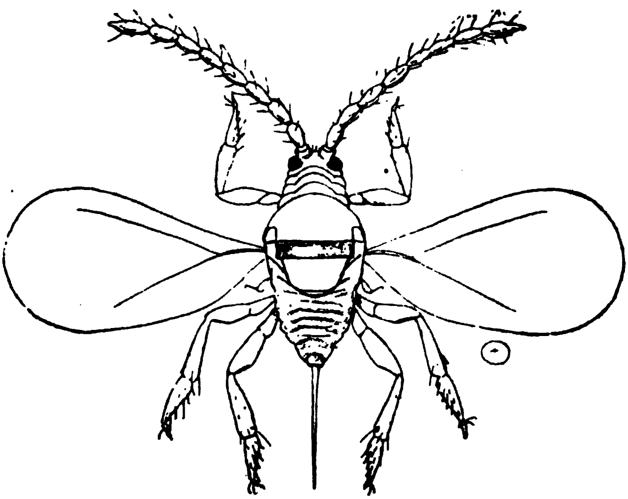


San José Scale.—*c* Adult female containing young—greatly enlarged; *d* anal fringe of same—still more enlarged.

All illustrations are after Riley and Howard, and used here by permission of the Secretary of Agriculture.

found in many other localities. Quite likely Michigan may meet with like results, though we know of no colony at present within our borders. We speak of the scale at this time and furnish illustrations from the Department of Agriculture at Washington, D. C., that fruit growers may acquaint themselves with this new and one of the worst of all orchard pests, and be on the watch for it, ready to stamp it out on the first appearance.

Apparently, scales were introduced from California in 1886 or 1887 on a lot of Kelsey plum trees imported by New Jersey nurserymen. From these trees the scales spread to the other nursery stock until all the trees were more or less infested by them. By 1889 or 1890 the nurserymen, entirely unaware of the presence of the scale or the mischief it would do, began sending the trees to purchasers and most of the known colonies are traceable to this New Jersey stock. From these facts we may infer that young trees that have been transplanted six years or less are most likely to have the scale on them, and every orchard and fruit tree that has been transplanted within that time should be carefully examined to see that it has no scale of this kind. Nursery stock should also be carefully inspected for the scale before transplanting; and, could we have state or district quarantine regulations against this and similar nursery importations, we would be far safer than conditions now permit.



San José Scale.—Male adult—greatly enlarged.

The scales will be most commonly found on the bark of the trunk and limbs though the young travel to the fruit and leaves. When left to themselves for a few seasons, they will cover an entire tree so thickly that the bark can rarely be seen and the tree has an ashy gray appearance; and, upon a closer examination, resembles a scurfy deposit. This species of scale can readily be told from the oyster shell bark louse (see Fig. 9), and in fact from all other scale insects on our deciduous fruit trees, by being circular and with a dark or yellowish dot in the center. The scales are from a twelfth to a sixteenth of an inch in diameter. They are flat,

fitting close to the bark, but can easily be scraped off with the finger nail and, when numerous, a yellowish, oily liquid will appear, resulting from crushing the living yellowish lice beneath the scales. "During winter the insect is to be found in the half-grown or nearly full-grown condition. The young begin to hatch and to crawl from under the female scales shortly after the trees leaf out and from this time through the summer there is a constant succession of generations."

The species is known to feed on such trees as the plum, cherry, pear, apple, peach, quince and rose, and is sure death to a tree within a very few years. Its spread into an orchard and into neighboring orchards is accomplished before people are aware of its presence and then it is very difficult to exterminate.

Remedies.—Mr. J. B. Smith of New Jersey has probably had a wider experience in treating this scale in the East than any other person and the following recommendations are condensed from his own:

1. The treatment should be made in the winter or while the trees are dormant if possible, as the remedies can be used stronger and made more effectual without injury to the tree at this time.

2. If there is loose bark on the tree under which the scales can hide, scrape it off. If the trees are large and difficult to reach, prune them back all they will bear and cart the brush away from the orchard.

3. Scrub or spray the tree thoroughly in every part with either a saturated solution of caustic potash or half and half of commercial potash and caustic soda, using about five quarts of water to each pound. This should be applied only when the trees are dormant. At any other time of the year whale oil soap, at the rate of two pounds to each gallon of water should be used.

4. Follow the first application a month later by an application of kerosene emulsion nearly full strength, as given by the formulæ under insecticides. The emulsion at this strength will do the dormant trees no harm and ought to kill every scale that escaped the potash solution.

DISEASES OF THE CHERRY.

BROWN ROT (*Oidium fructigena*, Kze. and Schm).

The leaves, flowers, fruits and sometimes the young stems of the cherry are attacked by this disease. The injury to the leaves or stems is seldom very severe, but, if the flowers or young fruits are attacked, the entire crop may be lost. It is most troublesome when wet weather occurs at, or soon after the time of flowering. The germinating spores enter the tissues and piercing the cells rob them of their contents. The germs of decay being admitted the so called rot ensues. Whenever warm weather follows periods of extended rainfall, we may look for the rot, and if the flowers or small fruits are attacked we may expect that the fruit will be considerably cut short.

The brown rot can be distinguished from ordinary decay by the fact that it produces immense numbers of yellowish-brown spores which appear in large clusters, often covering the fruit or stem. The diseased fruits gradually shrivel and often hang for a long time upon the trees (Fig. 23a).

In combatting this disease, it is particularly desirable that the early spraying with copper sulphate solution should be thorough, that no spores escape to spread the disease to the young leaves and flowers. As the disease is most likely to be troublesome at the time the early sorts are ripening, care should be taken to keep the fruit and also the leaves well covered with some fungicide, that the spores may be killed as they germinate and thus prevented from entering the tissues. After the fruit is half grown, it will be necessary to rely upon some of the soluble fungicides such as copper sulphate solution (dilute formula), or the ammoniacal solution of copper carbonate.

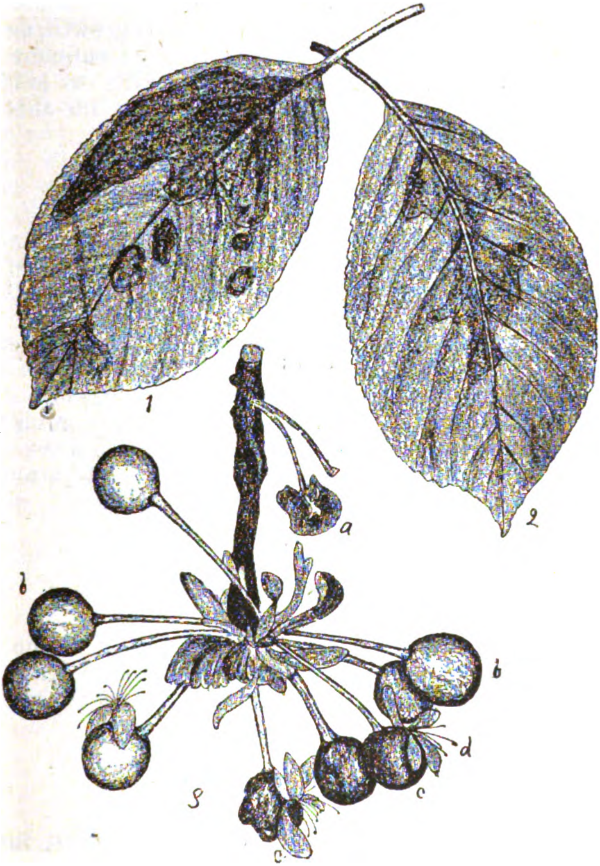


Fig. 23.—Brown Rot of Cherry (*Oidium fructigena*, Kze. and Schm).

1. Diseased leaf showing spots made by fungus, upper side.
2. Ditto, underside.
3. Bunch of cherries attacked by fungus.
   a. Cherry which was diseased the year before and has hung on the tree over winter.
   b. b. Green, healthy cherries.
   c. c. Diseased cherries with the blossom, d, clinging to the fruit.

—*After Galloway.*

POWDERY MILDEW OF THE CHERRY (*Podosphæra oxycantha* (D. C.), De By.).

Like other powdery mildews this form attacks the leaves and young shoots, often covering them with a fine white powder. It is especially injurious to young cherry trees, but it is also found upon the apple, peach, plum, quince, hawthorn, spiræa and various other plants of the rose family. It seldom appears before July, and is most injurious in hot, dry summers. The threads of the fungus form a web over the surface of the affected portion, and send up great numbers of fruiting stems, which divide into spores. Later on, the winter spores form upon the mycelium and give the fungus a grayish appearance. Under the microscope the black spores cases are seen to be flattened on one side, and to have long appendages, which bear at their extremities curiously branching tips (Fig. 29, 7). Occurring as it does late in the season, after the growth has been nearly completed, it seldom does much harm but, as it undoubtedly weakens the growth, measures should be taken to keep it in subjection. In most cases, the treatment recommended for the brown rot and shot-hole fungus will suffice to hold it in check. It some cases it may be necessary to spray the trees tor this disease later in the season than will be necessary for the others.

SHOT-HOLE FUNGUS (*Cylindrosporium padi*, Karst).

This and other closely allied fungi often do great injury to the different species of the cherry. It appears as small, purplish spots upon the leaves. These soon turn yellow and finally brown, and then drop out, leaving small round holes resembling those made by shot. Oftentimes a large number of holes appear in a leaf and as a result nearly all of the foilage drops from the trees. In this condition the trees are unable to ripen their wood, and, as a result of their unripened condition, are killed, even in a mild winter. It seldom appears until midsummer, but if the season is hot and dry, and particularly if the trees are neglected and uncultivated, it often causes large losses. If a little attention is given to spraying for this disease, after the fruit is gathered, using Bordeaux mixture once or twice, it will do little if any harm.

OTHER DISEASES OF THE CHERRY.

The cherry has a number of other diseases, most of which will be found described under other fruits; among them are the black knot (*Plowrightia morbosa*), the scab (*Cladosporium carpophilum*), and the rust (*Puccinia pruni*).

INSECTS OF THE CHERRY.

Besides the pear tree slug, spoken of above, the worst insect upon the leaves of the cherry is

THE BLACK CHERRY TREE LOUSE (*Myzus cerasi* Fabr.).

Frequently these lice so completely cover, distort and smear with excrement the cherry leaves that they are disgusting to behold; they not only stop the growth of the tree, but take much of the nourishment that should go to the fruit while maturing. As with all plant lice, they winter in the

egg stage, hatching early in the spring into females, which soon commence producing young, and by the time cherries are ripe we have several generations, each individual of which is producing several young each day. About July the lice disappear to the roots or to other plants. In the fall, winged males and females are produced and the females return to the cherry trees, there depositing their eggs around the buds for the next year.

Remedy.—If kerosene emulsion is used on the lice before they roll and knot the leaves around themselves, they can be very easily killed, but when protected by the leaves it is difficult to reach them with any remedy.

PLUM CURCULIO (*Conotrachelus nenuphar* Hbst.).

To the cherries the plum curculio is fully as injurious as to the plums, though the cherries do not drop as the plums do when stung, consequently we do not notice so great damage until we pick a luscious red cherry, apparently sound, and bite into it when we are very apt to meet disappointment. The cherry will grow around and cover up the crescent cut made by the curculio, while the plum will rot from the cut.

Although there is only one brood, the beetles do not all appear at once, and we must fight them, (this little, hard shelled beetle) for several weeks after the blossoms fall, if we save the fruit. If the cherries and plums are a full crop, and the curculio are not too numerous, we can save what the trees will mature by spraying with the arsenites. Spray as soon as the blossoms are all off, and this should be followed by two or three other sprayings at intervals of about ten days. The arsenites should be used with the Bordeaux mixture, as rains will be less likely to wash off the arsenic, and the plant diseases that attack the cherry and plum will be checked by it. If prospects are that this will not save the crop, jarring the trees by means of a padded mallet and collecting the curculio on a sheet should be resorted to. The arsenites are so slow in acting on the curculio that after one has eaten of a poisoned leaf or of the fruit, it will still live two or three days and in the meantime sting quite a number of cherries and plums.

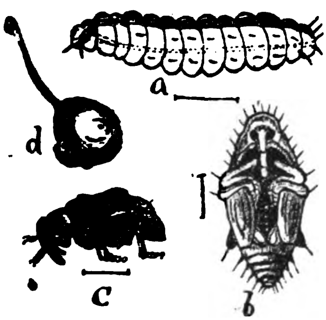


Fig. 24.—Plum curculio, *a*, larva; *b*, pupa; *c*, beetle.

6

DISEASES OF THE PLUM.

THE BLACK KNOT (*Plowrightia morbosa*, [Schw.] Sacc).

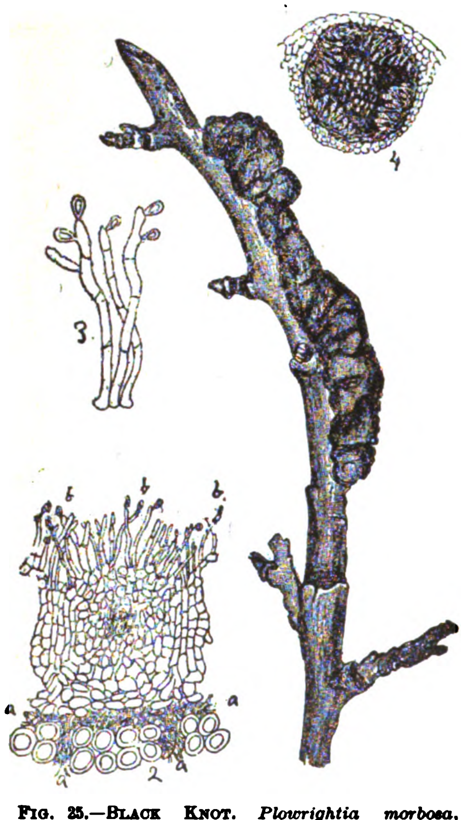


FIG. 25.—BLACK KNOT. *Plowrightia morbosa*, (Schw) Sacc.
1. Stem of plum tree with knot upon it, as it appears in the fall and winter.
2. Perithecium with mycelium, *a a*. between the cells of the stem, and covered with filaments bearing spores. *b*, at their extremities. Section made in May.
3. Filaments and spores, (*conidia*) more highly magnified.
4. Section through a cavity containing stylospores. After Farlow.

Although this disease is widely disseminated and has been very destructive to the plum orchards wherever it has appeared, farmers and fruit growers, as a rule, do not appreciate the danger of allowing it to get a start in their vicinity. In many sections of New York and New England, and in some portions of Michigan, it has been allowed to get a foothold and within two years the otherwise best cared for and profitable orchards have been entirely destroyed. With these terrible examples before us, every fruit grower should watch his trees and endeavor to save them from the scourge.

The larvæ of various insects are often found in the knots, and it has been claimed that they are the cause of the knots, but very often knots are found that do not contain insects and, moreover, the microscope and even the unaided eye shows that it is of a fungous nature.

The swellings (Fig. 25) are generally found upon the shoots of the previous year's growth, but may appear upon the larger branches, or the trunk. The spores enter the tissues, and the threads of the fungus and the cellular growth of the stem, due to the disturbance produced by the development of the fungus, causes the swelling, which often becomes several times the size of the branch. As it grows, the bark cracks and the spongy tissues below appear. The swellings begin to show during the month of May, and early in June will be found covered with an olive-green mould, which consists of the fruiting threads of the fungus, bearing at their tips the minute spores. These are borne about by the wind and in various other ways scatter the disease.

Later on, the surface of the knots becomes hard and black, and a careful examination will show it to be covered with minute pimples. These are the pustules which contain the winter spores of the fungus, which

ripen during the winter and serve as an additional means of scattering the disease. Each of the pimples contains a large number of spore cases or asci, in each of which about eight spores are contained.

Any person who has once seen a knot should be able to recognize them, as, not only are they well marked when in their summer and winter fruiting stages, but the appearance of the knots at any time is distinctive. There are several other forms of spores, but the conditions under which they develop is not certainly known.

When a knot has once commenced to form, no treatment with copper compounds can affect it, but it is likely that, if the trees are kept well covered, the spores will not be able to gain entrance.

The only safe thing is to watch the trees and cut off the knots whenever they appear. If they can be taken in hand in the spring, when the swelling first starts, and before the summer spores form, little harm will be done. The trees should be watched carefully during the summer, and should be examined at least once after the leaves have fallen, as the knots can then be more easily seen and, if they are cut off at any time before January, the winter spores will not have developed. In cutting off a branch, care should be taken that it is removed several inches below where the knot shows, in order that all of the mycelium of the fungus may be removed. If this is not done, the knot will be likely to show the coming spring below where the cut was made. Sometimes the knots are upon the trunks or large branches, which can not be taken off without injuring the trees seriously. If such is the case, it will be well to attempt to save it, if the knot has not become too old and hard. The swelling should first be pared off and tincture of iodine applied; this will follow the threads of the fungus and destroy them. The wound should then be painted with lead and oil paint, which will both aid in killing the fungus and prevent the drying out of the tissues.

In 1893 a law was enacted in connection with the "yellows" law, which provides for the destruction of the knots, in case the owners refuse to attend to it, under the direction of the commissioners.

The plum growing industry is becoming of much importance in many portions of the State but, it is likely to be of short duration, if the black knot makes its appearance in the orchards, unless the law is rigidly enforced.

LEAF SPOT (*Cylindrosporium padi*, Karst).

This disease, often spoken of as leaf blight and shot-hole fungus and which formerly was described as *Septoria cerasina*, has been one of the most troublesome, to the grower of the plum as well as of the cherry. It is quite generally distributed and often causes the winter-killing of thousands of trees, which through the loss of their leaves in August are unable to ripen their wood.

It shows first as small, purple spots, upon both sides of the leaves, and in a short time the tissues attacked take on a brown color. These affected spots frequently drop out, leaving small, round holes, whence one of the common names of the disease. With a lens it can be seen that there are one, or more, black dots on the under surface of the spots. These are the fruiting pustules within which the spores are produced in great numbers. The spores are long and slender and generally contain a number of cells. Each cell of these summer spores is capable of propagating the fungus.

After the spots have turned brown, the winter spores are formed, but they do not become fully developed until the following June, when they are found in pustules on the under side of the leaves in elongated asci, or spore cases.

When a leaf has many spots upon it they run together and thus destroy a large part of the tissues. As a result, the leaves drop and the fungus has thus not only robbed the tree of much of its nourishment, but it has deprived it of the ability to assimilate and prevented it from ripening its wood. As the fungus works entirely within the tissues, all remedies must be preventive, but the use of fungicides has been found even more efficacious than might be expected, as Bordeaux mixture, applied as recommended for the rot, will keep the trees free from leaf-blight. For the cherry and plum trees that are not in bearing, it should be applied in July, somewhere about the middle of the month and again about the first to the tenth of August. Had this remedy been employed for the past five years, not only would the lives of thousands of plum trees been saved, but the growth of others would have been largely increased.

PLUM POCKETS (*Taphrina pruni*, Fckl.).

The so called "Plum Bladders or Pockets" are due to a parasitic fungus. It causes the fruits to enlarge and become hollow, and finally drop to the ground. It is also quite common upon the branches of American varieties of plums, causing swellings to form upon them.

The fungus is carried over winter in the winter spores in the diseased fruits and branches, and these should be collected and burned. The spring application of copper sulphate will also do much to head off the disease and by the occasional use of Bordeaux mixture during the summer it can be held in check.

Of the other diseases of the plum, the "BROWN ROT" is most troublesome. It has been described at length under the cherry and peach upon which it also appears. The work of the fungicides can be greatly aided if the diseased fruits are collected and burned.

The "LEAF RUST" or BLIGHT which sometimes attacks the leaves of the plub and causes them to fall during hot, dry summers, is the same as upon the peach (*Puccinia pruni-spinosæ*). It shows first as small, yellow spots, which soon cause the remainder of the surface to turn yellow and finally brown and they then fall to the ground. The use of fungicides as recommended for the leaf-spot will generally be sufficient to hold it in check.

INSECTS OF THE PLUM.

Besides the plum curculio, spoken of under cherry insects, the plum tree suffers considerably from

THE PLUM TREE APHIS (*Aphis prunifolia* Fitch).

The life history of the plum aphis is similar to that of those on the apple, cherry and peach which have already been spoken of. When numerous the lice do considerable injury as they do not confine themselves to the leaves, but feed on the tender twigs and stems of the fruit, drawing so much sap from them that the plums shrivel and drop off for the lack of nourishment. The treatment is the same for the plum aphis as for the other Aphidæ—kerosene emulsion.

Where the aphis has been common on the plum trees, people often find plums with an insect on it resembling Fig. 26 and think it a new pest

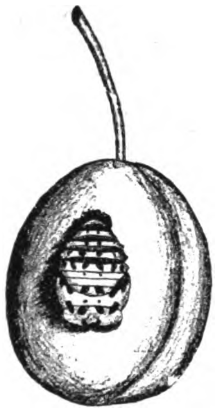


Fig. 26.—Pupa of *Anatis 15-punctata* attached to a plum.

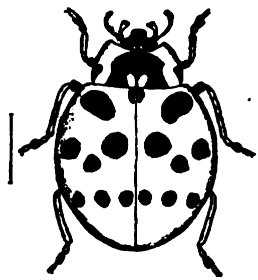


Fig. 27.—Imago of *Anatis 15-punctata*.

which has appeared for them to fight. The insect attached to the plum is the pupa of the little lady-bird beetle *Anatis 15-punctata* Oliv. This little lady-bird and the larva from which the pupa came, are insects that feed almost exclusively on plant lice and never injure fruit of any kind. They are friends, as they help rid the trees of the lice, and should never be killed if it can be avoided.

FUNGOUS DISEASES OF THE QUINCE.

While this fruit is attacked in all its parts by fungi, as a rule the diseases have not been very destructive in Michigan and most of them yield readily to fungicides and other treatment.

TWIG BLIGHT (*Bacillus amylovorus*, Burr.).

This disease, which is similar in its nature to the fire blight of the pear, has in some localities made inroads into the quince orchards. As a rule, it is confined to one or more of the branches, but in severe cases it spreads through the trees. It can readily be distinguished from the leaf blight as it causes the leaves to turn an even brown color and there is no appearance of spots as in that disease. The leaves also remain upon the twigs, which become dry and hard. While Bordeaux mixture will aid in keeping down the disease, it will not entirely prevent it, and the only remedy is to cut out and burn the diseased branches, making the cut several inches below where any sign of disease shows.

LEAF BLIGHT AND FRUIT-SPOT (*Entomosporium maculatum*, Lev.).

Of the other diseases of the quince none is more prevalent than the above, which is of a fungous nature and appears upon the pear in the same forms. In some seasons, particularly if the trees are grown without cultivation,

most of the leaves turn yellow and drop from the trees. As upon the pear leaves, small, circular spots appear and if numerous enough may run together and cover a considerable portion of the leaves. After a time small black specks appear in the center of the brown spots and indicate that the spores are being formed. This disease yields readily to the Bordeaux mixture, and, if three applications are given, the foliage will keep healthy and will remain much longer on the trees than when the trees are not sprayed, while the fruit will be free from spots. The fact that the trees retain the leaves will cause a marked increase in the size of the fruit and this will not only give a larger yield, but it will sell for a higher price per bushel.

THE QUINCE RUST (*Roestelia aurantiaca*, Pk.).

The orange rust of the quince attacks both fruit and stems, causing swellings, from which short, horn-like processes protrude, in which the reddish yellow spores are developed.

If the fruit is attacked while small, it will generally drop, but if it does not come until the fruit has reached some size, and if the spot is small, it will stop the growth of the portion attacked and cause the fruit to become misshapen.

The rust of the quince is one of the forms of the cedar apples, which are often found in the spring on the branches of the red cedar. As a preventive it will be well to destroy all red cedars that are near fruit plantations, especially if "cedar apples" are found upon them. Whenever the swellings are found upon the branches of the quince trees, or when they are seen upon the fruit, it will be well to remove and burn them.

If the trees are kept well covered with some fungicidal preparation, the spores will be killed as they germinate, and beyond the destruction of the red cedars this will be the only thing that can be done as a preventive. While it will greatly reduce the injury, if the rust has been troublesome it may not be entirely effectual, and pains should be taken to remove all of the portions that show the rust as soon as it appears.

THE ROTS OF THE QUINCE.

THE RIPE ROT (*Glœosporium fructigenum*, Berk.). PALE ROT (*Phoma cydoniæ*, Sacc.), and BLACK ROT (*Sphæropsis malorum*, Pk.).

The black rot often appears before the fruit is half grown, and causes the skin to turn brown. Small, dark pimples soon form beneath the skin, through which the greenish brown spores are protruded. The remedy for this disease is the same as for the rust, spray to destroy the spores as they germinate, and if any of them escape and cause the fruit to rot, destroy the diseased fruit as soon as it is seen.

The pale rot works much the same as the one just described, but the spots are at first nearly colorless and finally become of a light blue color. The tissues beneath soon become softened and the infected portion wrinkles up. The ripe rot or bitter rot is the same as is found upon the apple. The flesh sinks away and the brown depressions are covered with pimples in which pink colored spores are produced. As with the black rot the remedy for the last two diseases is to spray, and then see that all diseased fruits are destroyed.

Were a different treatment required for each of the diseases of the quince one would soon be discouraged, but, as in most other cases, the sprayings recommended for one will suffice for all, and the labor is after all not burdensome.

FUNGOUS DISEASES OF THE GRAPE.

DOWNY MILDEW OF THE GRAPE (*Plasmopara viticola* (B & C.), Berl. & De Ton.).

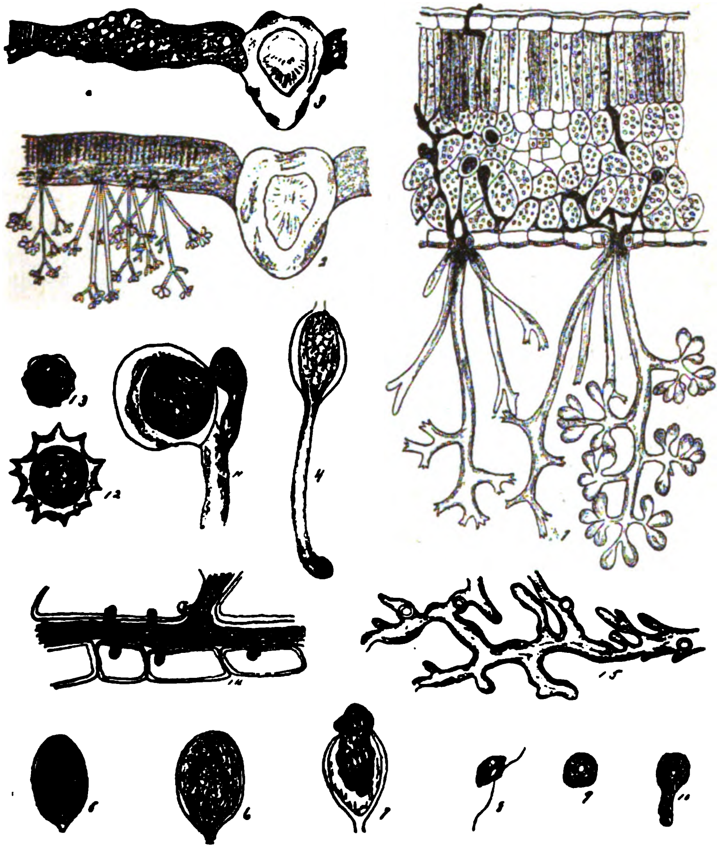


FIG. 28.—DOWNY MILDEW OF THE GRAPE, *Plasmopara viticola*.

1. Section of leaf (greatly magnified) showing conidial stage.
2. Showing the same, less magnified
3. The same, showing the effect of the fungus, the leaf brown and shriveled.
4. Germinating conidia.
5-8. Development of conidia through zoöspore and swarm-spore stages.
9. Spore.
10. Germinating spore.
11-13. Fertilization of oogonium and development of the oospore.
14. Section of leaf greatly magnified, showing mycelial thread passing *between* the cells, and sending its haustoria into them.
15. Branching mycelium, the spots representing haustoria. —*After Viala.*

This important fruit seems to be particularly subject to the attack of various fungous diseases and all parts of the plants, including stems, leaves and fruit are often so seriously injured that the crop of fruit is lost and the strength of the plant greatly impaired.

It is all the worse because they come at various times and under different conditions; thus the downy mildew is favored by cold, wet weather, while the so called powdery mildew luxuriates when it is hot and dry.

This disease, which is sometimes called the American Vine Disease, is often quite troublesome to the foliage and fruit of our grapes. The spores from which it develops, fall upon a leaf and in the presence of moisture quickly germinate. The germinating tube gains entrance through the breathing pores to the interior of the leaves and passing between the cells of which they are composed, sends its root-like haustoria through the cell-walls (Fig. 28, *14*) and absorbs the cell contents, to be used in its own development. This destruction of the cells causes brown or yellow spots to appear, after which the leaves turn yellow and finally brown, and this is the first indication that will be noticed of the presence of the disease.

If the conditions are favorable, the stalks upon which the spores are developed will push through the stomata on the underside of the leaves and ripen an immense number of oval, colorless, summer spores or conidia. (Fig. 28, *1* and *2*). The stalks and the spores together show as downy or frosty patches, generally on the underside of the leaves, although they may, if the attack is a severe one, appear on the upper side as well as on the leaf petioles and young branches.

The growth of the fungus and the development of the spores are well illustrated in Fig. 28. The leaf soon shrivels as seen at Fig. 28, *3*, and, later on, the thick-walled winter cells form within the leaves. Within them they fall to the ground and are ready to spread the disease the following year. While this disease may attack almost any variety, it is most likely to appear upon such kinds as are naturally weak, or that have become so through soil exhaustion, from over-bearing or from the attacks of insects or fungi.

The fungus checks the growth of the berries and causes them to turn brown so that the disease has often been termed brown rot. When the spores are developed upon the berries it gives them a grayish, mealy appearance. The disease is particularly troublesome in cold, wet seasons when the plants have been weakened by the unfavorable conditions under which they have been growing.

As in nearly all other cases a fungicide to be efficient against this disease should be applied before the spores have germinated upon the plants. This will necessitate an application early in the spring before the buds have swollen, for which spraying, copper sulphate solution can be used, and it should be applied thoroughly to all parts of the vines, the trellis and the soil beneath. In this way great numbers of spores can be destroyed. A second application, using Bordeaux mixture, should be made when the first leaves are about one-half grown, and this should be repeated as soon as the fruit has set. The later applications should be made at intervals of from ten to fifteen days according to the weather and the prevalence of the disease. If the summer is cool and wet, as many as five or six applications can be made with profit, and although when the disease is very prevalent the foliage and fruit may not be entirely protected, yet the injury will be very slight, while were no use of the fungicide whatever made, the entire crop might have been lost.

POWDERY MILDEW OF THE GRAPE (*Uncinula ampelopsidis*).

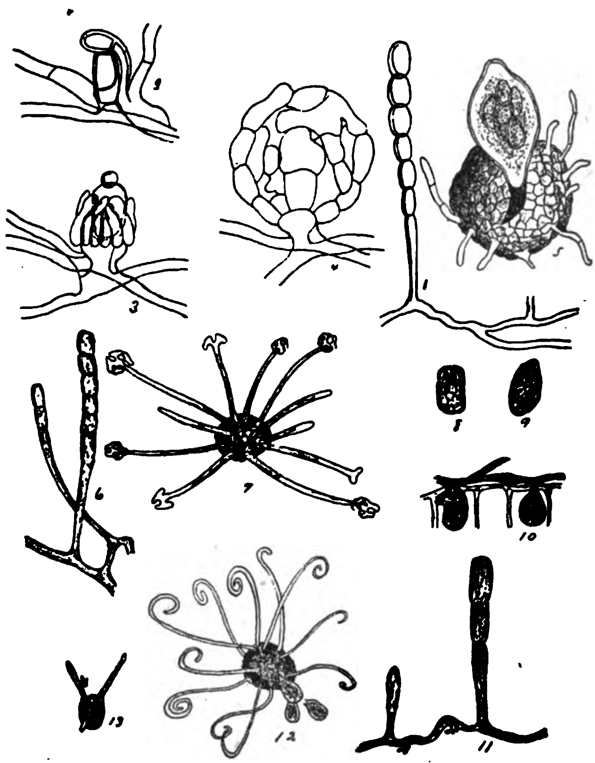


Fig. 29.—Powdery Mildews of Rose, Cherry and Grape. *1*, summer spore of rose mildew; *2-4*, development of carpogonium; *5*, winter spore (*perithecium*) with ascus, containing ascospores escaping; *6*, summer spores of cherry powdery mildews; *7*, winter spore of same; *10*, mycelium with haustoria in cells; *11*, *12*, *13*, the same, of the powdery mildew of the grape.—*After De Bary*.

The so called powdery mildew is particularly troublesome in seasons when it is hot and dry, and it attacks the foliage and young shoots as well as the fruit. It is particularly troublesome to the varieties that are hybrids of *Vitis vinifera*, the European wine grape. The fungus lives upon the surface of the leaves and obtains its food by sending root-like suckers called haustoria, into the underlying cells, from which they absorb the contents. The summer spores are borne upon simple spore stalks (Fig. 29, *1*) and serve for the rapid reproduction of the fungus. The formation of the winter spores is illustrated in Fig. 29, *4*. The spore cases of the grape powdery mildew can be readily distinguished from others by having the extremities of their appendages arranged in coils.

The thick covering of the winter spores (*perithecia*) serves to protect them from extremes of temperature and moisture during the winter.

The affected portions, during the first half of the season, take on a whitish, powdery appearance, which, later on, changes to a light brown, owing to the presence of great numbers of winter spores. As both the spores and the body of the fungus are upon the surface of the leaves, it is easy to destroy them wherever the copper compounds can be brought into contact with them, but, as it often appears inside the fruit clusters, it is difficult to exterminate if it once gets a start. The sprayings with Bordeaux mixture, that are generally applied for the other diseases, will do much to hold it in check, during the early part of the season, but, later on, as the fruit approaches maturity, the weak copper sulphate or the ammoniacal carbonate of copper will be preferable. The application of flowers of sulphur to such varieties as are subject to this disease, at intervals during the season, will also be of value, especially on grapes grown under glass.

In dry seasons the frequent stirring of the soil will aid in keeping the vines healthy, but, upon its first appearance, recourse should be had to one of the above fungicides.

THE BLACK ROT OF THE GRAPE (*Phyllosticta labruscæ*, Thüm.) (*Laestadia Bidwellii*, (Ell). Via. and Rav.)

In some seasons this disease has played havoc in the vineyards in the southern part of the State practically ruining the crops. The brown spot disease of the foliage is the same as causes the rot upon the fruit, and, in fact, it generally manifests itself there first. Upon the fruit it shows as small, brown spots, which gradually enlarge until the entire berry has a rotten appearance. Up to this time they generally retain their spherical form, but the point first attacked soon begins to shrivel and finally the berry dries away, until it consists of the seeds, covered by the dried pulp and skin, the latter in folds and furrows that are always distinctive of the disease. In the meantime small black pimples have appeared upon the berries; these are the perithecia in which the winter spores are developed.

The fungus also has other reproductive bodies that are developed in great numbers, especially if the weather is warm and moist, and as the same conditions favor the rapid germination and development of the fungus, the injury from the disease is greatly increased when these conditions are present.

Experiments have demonstrated that in sections where this disease is troublesome, it can be held in check by the judicious use of copper compounds. If the vines are thoroughly sprayed in the spring before the growth starts, with a strong solution of copper sulphate, and at intervals of two or three weeks using Bordeaux mixture up to the time the grapes are half grown, and after that a weak solution of copper sulphate or ammonical copper carbonate, there will be but little if any loss from this disease, and other fungous diseases will be held in subjection by the same applications. As a rule no application need be made latter than the first of August.

ANTHRACNOSE (*Spaceloma ampelinum*, De By).

This disease is a comparatively new one in this locality and, so far as is known, has appeared in but a few sections in Michigan, and there has done but little harm, as it seems to confine itself to a few varieties, particularly Champion and Vergennes.

It attacks all new parts of the plants and may appear at any time during the growing season. Upon the leaves, it appears as sunken, brown spots with slightly raised rims. The spots generally become elongated and the dead tissues take on a white color. It has a similar appearance upon the stems, but it may extend so deep as to practically girdle the branches and cause the loss of both leaves and fruit. The fruit also is very likely to be attacked, the spots at first showing with reddish-brown borders and gray centers. The berries finally wither and dry up until only the skins and seeds remain, but, if the spots are small, the portion free from disease may keep on growing and, as a result, the berries will crack and expose the seeds. When they wither in this way, they appear quite unlike those attacked by black rot, since they do not turn brown as in that disease, nor do they take on the wrinkled and pimply appearance so characteristic of black rot.

If this disease is allowed to get a start, it is generally quite destructive and not only should preventive measures be used, but if it makes its appearance it will generally pay to cut away and burn the infected portions.

The treatment with Bordeaux mixture as recommended in the spraying calendar will do much to hold the disease in check and if persistently kept up will prevent it from gaining a foot-hold. The treatment should begin early and should be frequently repeated.

SHELLING OF THE GRAPE.

In some seasons numerous complaints are received of the shelling of the grapes from the bunches, the stem breaking short off next to the berry, instead of drawing out from the fruit as is the case in healthy berries. As a rule, the berries at the lower end of the cluster, or at the extremity of the shoulder, are the first to shell, and the bunches nearest the extremity of the canes generally suffer most.

The disease does not seem to be of a fungous nature, but, as a rule, it is due to something that has caused a weakness in the plant. This may be due in whole, or in part, to some fungus that has attacked the foliage and has injured the assimilating powers of the plant. If the fungus has proper treatment, there will be no danger of injury from this source. While insects are seldom, if ever, the direct cause of the disease, it is possible that some of them, particularly those that suck the suck the sap from plants, may serve as the inducing cause. In many cases, it has been found that the application of mineral fertilizers to vineyards has given crops free from the trouble. This may be attributed to the fact that the soil was deficient in either potash or phosphoric acid, particularly the former, and that they served to give a firm growth and to check the tendency of the plant on soils unduly rich in nitrogenous matter to waste their energies in the production of shoots and leaves, at the expense of the ripening crop. On cold, poorly drained soils, where the plants could not get a proper supply of food, the disease has also been troublesome.

As a rule, there will be little trouble from this disease if the vineyard is on soil of a suitable character, and where the plants receive suitable food and cultivation, avoiding the use of stable manure for the most part and depending for an artificial supply of plant food upon wood ashes, ground bone and similar mineral fertilizers.

INSECTS OF THE GRAPE.

GRAPE VINE FLEA BEETLE (*Haltica chalybea* Ill.).

The worst enemy to the grape early in the season is this little steel blue beetle (Fig. 30). Before the buds burst the beetles are gnawing into them and often destroy whole vineyards before it is time for leaves or blossoms to appear. Usually they destroy only a portion of the buds and then feed on the leaves, first as the imago and later as the larvæ from the eggs deposited on the leaves by the parent beetles. The young are dark brown, hairy and minute. When full grown they are considerably less than half an inch long, and are a dirty, light brown. At this stage they drop to the ground, bury themselves, transform, and, a few days later appear as a second brood to again feed on the leaves. This brood does little harm compared with that of the first, though they and the larvæ often riddle the leaves with holes and eat all but the larger veins.

Fig. 30.

Remedies.—The larvæ and beetles feeding on the *leaves* may be readily killed by the arsenites, but this is of little avail where the beetle is at work in the bud where the arsenites will not reach it, and probably the best thing we can do is to jar the beetles off into a broad pan with a little kerosene in the bottom or on a stretched cloth well saturated with the same. The vines are closely pruned and cover but little space at the time the beetles appear so that the whole vineyard can be quickly gone over in this way. The beetles will readily drop, when the weather is a little cool. As a preventive, keep all rubbish picked up, and fallen leaves raked from the ground so that the hibernating beetles will be without protection. Grape vines growing in grass are much more liable to attack than those that are cultivated.

LEAF HOPPERS.

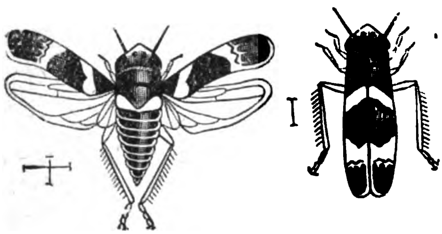


Fig. 31.—Grape Vine Leaf Hopper (*Erythroneura vitis* Harr.).

There are several species of leaf hoppers that suck the sap from the leaves of the grape until they become speckled, brown, and may even wither and drop off. These leaf hoppers, one of which is shown in the cut, are prettily marked and banded. The most injurious one in Michigan (*Typhlocyba tricincta* Fitch) is nearly pure white with three black bands crossing it. The individuals are about one-eighth of an inch long. They work mostly on the under side of the leaves and quickly jump or fly to some other part of the vine when disturbed.

Remedy.—A spray of kerosene emulsion thrown on the underside of the leaves in the cooler part of the day.

The ROSE CHAFER is very fond of the blossoms and young fruit of the grape. It has already been treated of under insects attacking the peach.

CLIMBING CUT WORMS also attack the fruit and foliage of the grape, but have already been spoken of under the apple insects and the same preventive should apply here.

For the LARGE CATERPILLARS that are occasionally found on the grape vine leaves, it hardly seems necessary to suggest anything more than hand picking, though the arsenites may be used.

DISEASE OF THE STRAWBERRY.

LEAF-BLIGHT (*Sphærella fragariæ*, Sacc.).

In some seasons this disease proves quite destructive both to plants and the crop. It first appears upon the leaves as reddish-purple spots, which soon turn brown and finally white. Upon these spots one form of spore is developed, which is used to spread the disease during the summer, while in the fall and winter a form is produced which in the spring causes the infection of the new leaves as they are developed. Not only does the

disease greatly reduce the leaf area of the plants but, by attacking the fruit stalks and the calyx, it tends to deprive the fruit of its nourishment, which results in its shrivelling, and the entire crop may be ruined.

Starting with strong and healthy plants, from plantations that have not exhausted themselves by fruiting, and keeping the foliage well covered with Bordeaux mixture, during the first season, there should be little if any signs of the rust at the beginning of the second year. The plants should be thoroughly sprayed with Bordeaux mixture, just as the first blossoms are opening, which will admit of thoroughly coating the flower stalks and the calyxes of the flowers. If the spraying was properly done the first season, no further application will be necessary, but if it was neglected so that it is present to any extent upon the leaves, it will be well to give a second spraying, using copper sulphate solution at the rate of one pound of copper sulphate to two hundred and fifty gallons of water, when the first berries that set are about one-half grown.

If the plantation is to be kept another season it should have an application of Bordeaux mixture soon after the fruit has been gathered.

STRAWBERRY INSECTS.

INSECTS OF THE ROOTS.

The fruit and leaves of the strawberry suffer but little from insect attack to what the roots and crown do. The CUT WORMS that are the farmer's dread at corn planting time, are sometimes destructive to the roots and crown of the strawberry by cutting them off in feeding on them.

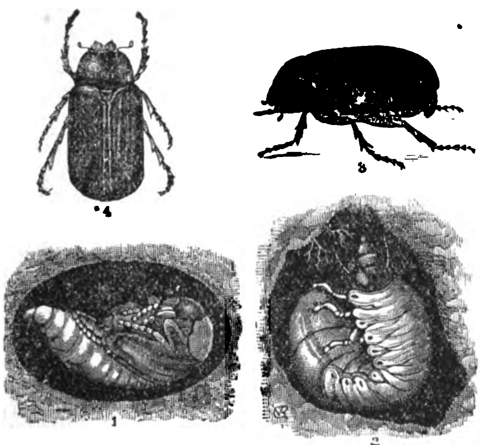


Fig. 32.—*3* and *4*, May Beetle; *2*, larva or white grub; *1*, pupa.

The WHITE GRUB, or larva of the May beetle, often feeds on the roots and at times becomes quite destructive. One of the worst pests when it does occur is the

STRAWBERRY ROOT BORER (*Anarsia lineatella*).

It is also the second worst enemy to the peach in this State where it is known as the peach twig moth, because it bores into the twigs and early buds of the peach as they are expanding and kills them. In the strawberry it bores into the crown and down through the heart into the larger roots and usually kills the plant. Closely related to the root borer in work is the STRAWBERRY CROWN BORER (*Tyloderma fragariæ*) which, in the grub state destroys the crown by boring into it.

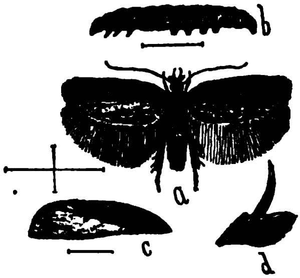


Fig. 83.—Strawberry Root Borer; *a*, moth; *b*, larva; *c*, pupa.

Remedy.—Probably the most satisfactory remedy is a rotation of crops so that the plants will not bear more than two crops of fruit before they are plowed up and a new bed planted in another place. If the insects are known to be at work in the plants at the fruiting season, the plants should be burned before the insects have time to mature and escape.

DISEASES OF THE RASPBERRY AND BLACKBERRY.

ANTHRACNOSE (*Glœosporium venetum*, Speg.).

When the young canes are about one-half grown, small purplish spots often appear upon them, and in a short time the centers of these spots become white. If the spots are sufficiently numerous, a considerable area of the canes may be infected and great injury may be done, as not only will the fungus take up the sap of the plant, but, the tissues being broken, there will be a very rapid loss from evaporation, and the spots may dry out to a considerable depth.

The disease may extend to the small branches, fruit stems and to the leaves. If the area involved is sufficiently large, the entire circulation may be cut off, and the berries and upper portions of the canes will dry up.

In the case of an old plantation, the old canes and those of the new ones that are most infected should be removed as soon as the crop is gathered, or at any rate early in the following spring, and the remaining plants should then have a thorough spraying of copper sulphate solution or of Bordeaux mixture, with later applications the same as for a new plantation.

When a new plantation is to be put out, the plants should be obtained from a young plantation that is but little if any infected with the disease. In the case of red raspberries and blackberries, it will be desirable to have plants that have been grown from root cuttings. They should be thoroughly sprayed at least three times the first season and the second season it will be well to spray before the buds start, again as the new canes are a foot or so high, and a third time after the crop has been gathered. For the first and second applications, the copper sulphate solutions can be

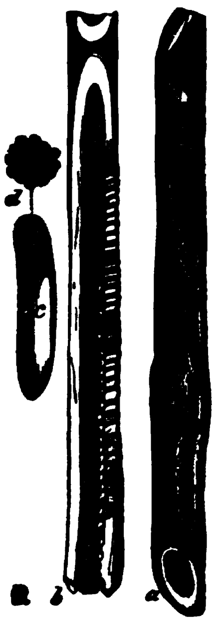
used, remembering that, after the foliage is out, it is not well to use more than one pound of the copper sulphate for two hundred and fifty gallons of water.

RED RUST (*Cæoma nitens*, Schw.).

Plantations of both blackberries and strawberries, particularly the former are often greatly injured by this disease. It appears upon the young stems, generally when they are about one-half grown and may extend to the petioles and ribs of the leaves. It lives in the tissues and finally bursts through the epidermis and scatters its numerous orange-colored spores. As a rule, the pustules are considerably elongated, following the furrows in the stems and branches. When the disease appears, the plant should at once be cut out and burned, and if much of the shoot is involved the entire stool should be sacrificed. The neighboring plants, and desirably the entire plantation, should then be sprayed with copper sulphate solution or Bordeaux mixture, to prevent the infection of other plants. In some cases this disease has been very destructive, ruining entire plantations, and every effort should be taken to prevent its spread.

INSECTS OF THE RASPBERRY AND BLACKBERRY.

THE TREE CRICKETS.



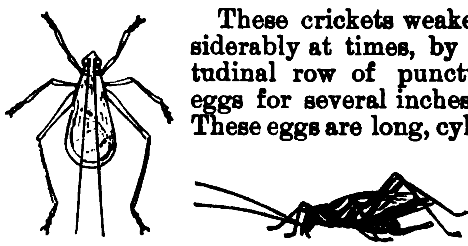


Fig. 34.—Male and female of a Tree Cricket; also canes containing eggs.

These crickets weaken the canes considerably at times, by making a longitudinal row of punctures filled with eggs for several inches down the canes. These eggs are long, cylindrical, curving slightly and look considerably like a grub, for which they are often mistaken. They are laid in the fall and remain through the winter. The young crickets instead of feeding on the canes in the spring, when they hatch from these eggs, leave the canes and feed on plant lice and succulent green food and fruits. Our most common species is *Œcanthus fasciatus* Fitch.

There is no satisfactory remedy except to cut out and burn the canes containing eggs in the fall or early spring. Clean culture of the berry patch and borders is an excellent preventive. If these two points are observed, no extensive injury need be feared.

RED NECKED AGRILUS (*Agrilus ruficollis* Fabr.)

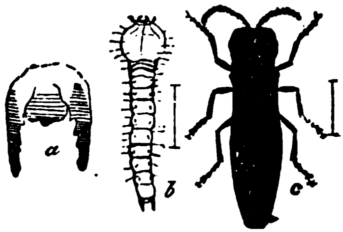


Fig. 35.—Red Necked Agrilus: b, larva; c, imago.

In pruning the raspberry canes, one will often observe a swelling of the cane for an inch or two. The swelling is apt to be cracked and roughened, manifesting an unhealthy growth. This gall has been termed the raspberry gouty gall. It is produced by a small white grub that works in the cane under the bark. The borer matures in early spring, transforms to a pupa in the pith of the cane and in June comes forth as a beetle to deposit eggs on other canes for a following generation that will mature the next year. The beetles work more extensively on wild than cultivated raspberries.

Remedy.—Cut out and burn the galls before June.

THE RASPBERRY SAW FLY (*Monophadnus rubri* Harr.).

For the past year or two, reports have come to us of this saw fly stripping whole patches of bushes often of several acres in extent. Every year a few are seen on the college patches, but no harm has been done. They are a green, hairy slug, working on the underside of the leaf and resembling it so closely that one must look carefully to detect them. They cut irregular holes in the leaf, often nearly perforating it, but when nearly grown and now measuring over half an inch in length, they may often be found feeding on the edge of the leaf. There is but one brood each year so by the end of June the larvæ leave the bushes and enter the ground where they transform and appear as a four-winged fly the following spring to again lay eggs for another brood.

Remedy.—Spray with hellebore or the arsenites, striking the underside of the leaves as much as possible.

DISEASES OF THE GOOSEBERRY.

THE POWDERY MILDEW (*Sphærotheca Mors-uvæ*, [Schw.] B. and C.)

Although the European varieties are particularly subject to this disease, it frequently appears upon those of American origin. While they grow luxuriantly in England and in many parts of continental Europe the cool, moist climate being particularly favorable for them, the European gooseberries suffer a serious check in our hot, dry summers and are quite likely to be attacked by powdery mildew, which as previously stated, like all others of its class, luxuriates in a warm, dry atmosphere.

In a general way, the descriptions that have been given of the other powdery mildews will apply to this one. It appears early in the season upon the young leaves and tender shoots, and has at first a cobwebby appearance, but, when the spores have formed it has a white powdery look and later on becomes brownish, owing to the presence of the dark-colored, winter spore coverings. The growth is checked and in severe cases the leaves drop off leaving the bare stems. The action of the fungus upon the fruit is to check the growth of the portion attacked, and cause it to become misshapen. In many localities it has been useless to attempt the cultivation of the European varieties on account of this disease. Attempts have been made to grow them under conditions similar to those to which they are accustomed, by planting in deep, rich, moist soil, and mulching the plants. Others find them fairly successful on the north side of a fence or building. The use of sulphur was also tried and seemed to have a good effect, but within the past five years a better remedy has been found in liver of sulphur (sulphide of potassium). While Bordeaux mixture is even more effectual and is preferable on account of its sticking qualities for use early in the spring, it is better to use the potassium sulphide or weak copper sulphate solution after the fruit is half grown, as it will not spot the fruit. To keep the European sorts free from mildew, it is well to spray the plants once in from two to four weeks from the time the leaves come out until the middle of August. The longer time will answer if insects or mildew do not appear, but, whenever it manifests its presence, the fungicide should be applied at once, together with Paris green or pyrethrum according to the season, if worms trouble.

While the mildew is the most troublesome of the diseases of the gooseberry, it is sometimes seriously injured by several "leaf-spot" diseases, which will be described as affecting the currant, and the rust (*Æcidium Grossulariæ*, Schum.). As a rule, the treatment recommended for the mildew will suffice for the others.

DISEASES OF THE CURRANT.

Frequently the foliage drops from currant plants during the summer, owing to the presence of fungi, of which the most common are the so called spot diseases (*Septoria ribis* and *Cercospora angulata*, Winter). These differ but slightly from the other spot diseases and cause small, brown spots to show on the leaves during June and July, and, the tissues being destroyed, the affected portion drops out. In several ways the spots caused by these diseases bear some resemblance to the strawberry leaf-blight and may in time be referred to the same genus.

In sections where this disease is troublesome, the spraying of the plants should not be neglected. By the use of two or three applications the leaves can be retained upon the plants throughout the season.

CURRANT AND GOOSEBERRY INSECTS.

THE CURRANT SAW FLY (*Nematus ribesii* Scop.).

This imported currant worm has been a pest among us so long and is so well known that it needs no introduction. The imago of this insect is not so well known and a cut of the male and female is given. Two broods of this saw fly appear each year, but the most destructive one comes early, when the flies will be very noticeable around the bushes in the warmer part of the day. When the leaves are unfolding the little white eggs are

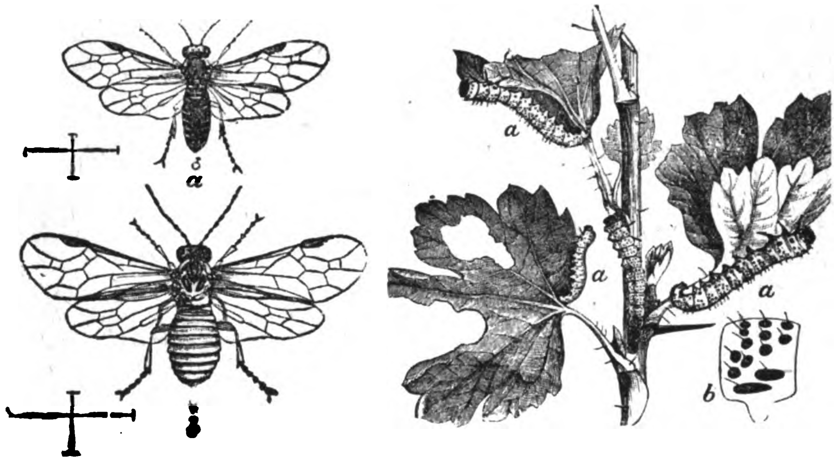


Fig. 36.—Currant Slugs and the Saw Flies to which they change.

laid along the midrib of the leaves, and from these eggs the young slugs will soon appear. While they are still very young is the time to treat them with a spray of Paris green. If thoroughly treated at this time and heavy rains do not appear too soon, the currant slug will not injure the bushes again through the season. If another spraying is needed when the fruit is nearly ripe, hellebore can then be used. The currant worms hatch first, and are thickest, low down in the center of the bush and care should be used to spray thoroughly in that part.

CURRANT BORERS.

There are at least three species of borers that work in the canes of the currant and if not interfered with will ultimately kill the bushes. In early summer the eggs are laid singly near buds, and the young borer works through the bud into the pith of the cane where it feeds until late fall or early spring when it changes to a pupa and later appears as the imago.

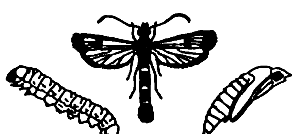


Fig. 37.—Imported Currant Borer, *Sesia tipuliformis* Linn., in larva, pupa and imago stages.

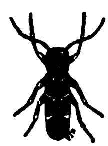


Fig. 38.—American Currant Borer, *Psenocerus supernotatus* Say.

Remedy.—The remedy is the same for all three of the borers. The dead and injured canes can be told as soon as the buds are opening and should at this time be cut out and burned. This will destroy the borer before it can mature and escape.

THE SPAN WORM (*Eufitchia ribearia* Fitch).

Fig. 39.—Currant Span Worm; *1* and *2* represent the looping caterpillars; *3*, the pupa.

The span, or looping caterpillar of the currant and gooseberry, when it appears in a locality, is usually quite destructive by very quickly stripping the bushes of their leaves. The cut shows the caterpillar, natural size, in a few of the many attitudes which it assumes, and represents it so well that no description is needed. There is only one brood in a year and this brood often has its numbers greatly reduced by parasites.

Fig. 40.—Currant Span Worm Moth.

The remedy is Paris green when it can be used without poisoning the fruit, otherwise hellebore.

THE YELLOW LINED CURRANT BUG (*Pœcilocapsus lineatus* Fabr.).

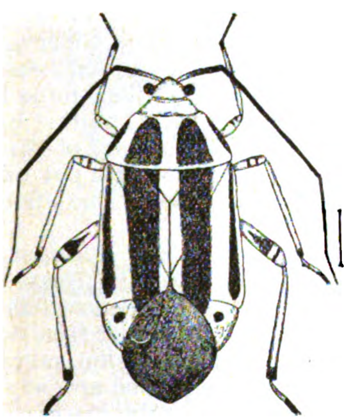


Fig. 41.—Yellow Lined Currant Bug.

The injury done by this bug is in puncturing the young leaves so that little brown blotches appear and later, when these spots become more plentiful, the leaves will wither and drop off. The bug is quick and active and when approached dodges to the other side of the leaf or drops to the ground. The line at the right of the drawing shows the natural size of the the bug.

Remedy.—Spray with kerosene emulsion.

INSECTS OF THE CABBAGE.

The cabbage is a great sufferer from insect attacks. From the time the plants are large enough to transplant until they are harvested, they are beset with numerous insect pests. The earliest species to attack cabbages is

THE CABBAGE FLEA BEETLE (*Phyllotreta vittata* Fabr.).

Fig 42.—Cabbage and Turnip Flea Beetle.

Not only young cabbages, but turnips, radishes, tomatoes and many other plants suffer from the work of this pest. The minute shining black beetles, with two wavy white lines above, are shy and will leap a long distance on being approached. They gnaw little holes in the leaves of the young plants and later the larvæ feed on the roots. There are several broods, but the first one does the harm.

Remedies.—Lime or land plaster dusted over the plants is a very good protection. Tobacco as a dust or a decoction is generally considered more effectual.

THE CABBAGE ROOT MAGGOT (*Phorbia brassicæ* Bouche).

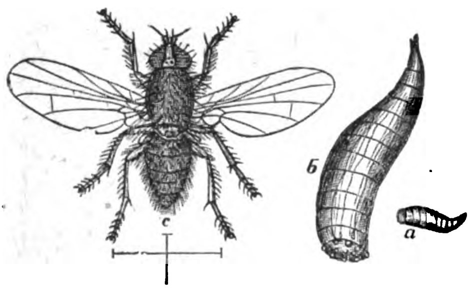


Fig. 43.—Cabbage Root Maggot. (*a*) maggot natural size, (*b*) magnified; (*c*) imago.

The cabbage root maggot is a difficult pest to manage, as its work is usually at an end before the cabbage shows any outward signs of its work, and then a remedy comes too late. The roots are so badly eaten and perforated that the cabbage plant soon dies. On pulling the wilted plant, the most of the root will be found to have been eaten and the remainder often in a decaying condition. Occasionally a little white maggot, less than one-fifth of an inch long, will be found in digging up an affected plant. Usually by the time a plant has reached this stage, the maggots have burrowed a short distance away from the root and will be found as pupæ resembling, somewhat, a little oblong brown seed. The pupa later changes to a fly that is much like our common house-fly. The first brood of maggots, that attack the cabbage roots in the latter part of May or early in June, is the most destructive one, but young cabbages put out in early July also suffer from an attack by the second brood. The life of a maggot is from three to four weeks.

The best means to protect from the maggot is to plant cabbages and radishes in a new place each year, as far removed from the ground on which they were raised the preceding year as possible. The most successful *remedy* that we have yet found is an emulsion made either from crude carbolic acid or from kerosene. A quantity of this emulsion, prepared according to directions given under "Insecticides," is poured around each plant sufficient to wet the roots at about the time the maggots are expected to appear, or even immediately upon the first appearance of injury. Mr.

Slingerland of the New York experiment station has studied the cabbage maggot extensively and he favors the carbolic acid to the kerosene emulsion. He also had good success with bi-sulphide of carbon by putting it around the roots with a McGowen injector. Prof. Cook had very poor success with the bi-sulphide of carbon in light or sandy soil, but in clay it worked well.

"THE CABBAGE WORM" (*Pieris rapæ* Linn.).

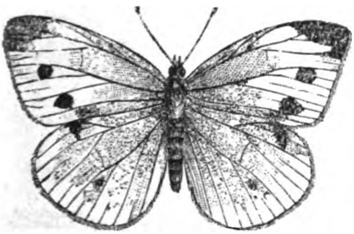


Fig. 44.—Cabbage Butterfly.

The adult of this common caterpillar is a white butterfly (Fig. 44). The female lays her small yellowish eggs on the cabbage leaves, and they soon hatch into the green velvety caterpillar that makes such havoc with the cabbages the rest of the season. There are at least two broods, but they are so irregular that there seems to be only one continuous brood. Although there is a disease that kills many, and many more are killed by predacious insects and parasites, yet we can never rely wholly upon them to keep the cabbage worms in subjection. It is encouraging to know that in large cabbage fields this caterpillar is not common enough to do much harm. The farmer who raises a few for his own use is the one who must fight them if he secures cabbages worthy the name. Many perfectly absurd remedies are in use for this pest. There are also many practical ones, the most common of which are the arsenites, pyrethrum, kerosene emulsion and hot water. For a farmer with only a few cabbages in his garden near the house, my preference is the last one. The cabbage will endure water almost boiling, to within 30 degrees at least, while the caterpillars are killed by water above 130 degrees, giving a range of temperature of 50 degrees or more, inside of which one can surely guess near enough. It takes little time to heat a kettle of water, carry it to the garden and pour it over the cabbages, after which they will be clean, and left free from all powder and dirt.

THE ZEBRA CATERPILLAR (*Mamestra picta* Harr.).

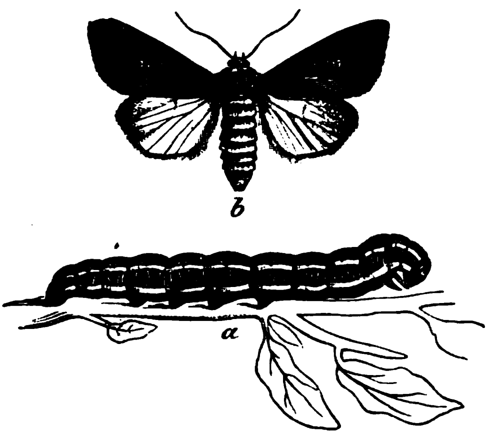


Fig. 45.—Zebra Caterpillar and Imago.

Sometimes in the latter part of the season this yellow and black banded caterpillar becomes plentiful enough on cabbages to need treatment. If so, use the same remedy as for the common cabbage worm.

CABBAGE APHIS (*Aphis brassicæ*).

Although not as destructive to cabbages as the cabbage worm, the little downy green lice, that cover so many of the cabbages in the fall, are about as unpleasant a pest as we have, and they take a great deal of nutriment from the plants too. Late in the fall eggs are laid on the cabbage leaves for the next year's brood and for this reason all refuse leaves and stumps should be burned, or gathered and fed to stock. This will greatly aid in reducing the number of lice for the next season. As a remedy, kerosene emulsion is the most effectual, but it must strike the lice on both upper and under side of the leaves, and wherever found, else many will escape.

CABBAGE LEAF MINER (*Plutella cruciferarum* Zell.).

Occasionally this leaf miner has proven harmful to cabbages, rutabagas, and similar cruciferous plants, by the young larvæ boring into the leaf between its upper and under surface and raising a blister by feeding on the substance of the leaf and making small dead spots before the larvæ mature.

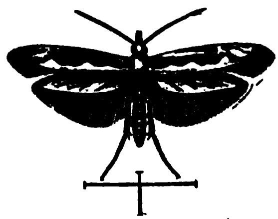


Fig. 46.—Moth of the Cabbage Leaf miner.

Remedies.—Paris green is recommended for the miner but I believe hot water as advised for the cabbage worm will prove more effectual.

INSECTS OF THE CUCUMBER AND SQUASH.

THE STRIPED CUCUMBER BEETLE (*Diabrotica vittata* Fabr.).

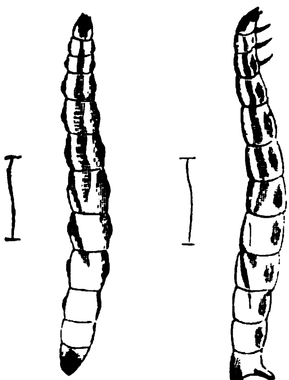


Fig. 47.—Striped Cucumber Beetle and Larvæ.

If the only harm done by this insect was by the imago above ground, we could control its work much better, but the beetle lays its eggs at the base of the roots and the little white grubs resulting from them feed on the root all through their development. This often causes the plants to suddenly die without any apparent cause, but if the plant is pulled up, we will see that the root is badly gnawed or entirely eaten off. The same beetles are equally as harmful on melons and nearly as bad on squashes. There is also a plant disease that is carried by these striped beetles and if we can keep them from the plants, we in a large measure prevent this disease from its attack. The disease makes its appearance when the plants are large and beginning to run and they die as suddenly and unexpectedly as does the squash from the same disease.

Remedies.—Carbolized lime or tobacco dust are either one very good in protecting these plants, *provided,* we dust the plants before the beetles have gotten a taste, and *provided* we apply often enough to keep the plants well covered. Where one has only a few plants, a very sure protection is to cover them as soon as the beetles appear, with a box or frame that is covered with netting, so as to exclude them from the plants but admit the sunlight.

SQUASH VINE BORER (*Melittia ceto* Westw.).

Many reports of injury to the squash by the borer have reached us from various parts of the State. No doubt quite a per cent of this work is due to the disease spoken of under the striped cucumber beetle, yet we know that the borer is a dreaded pest in many localities around us. The borer is closely related to the peach tree borer and works in the base of the stem and top of the root so that it and its work can readily be found if a plant dies and the borer has been the cause of its death.

Remedies.—If the larva is once inside the plant there is nothing that will save it except making a longitudinal cut in the stem and digging the larva out. The moth lays its eggs at the base of the plant soon after it is up, or at least before it has run far. Some have had good success in spraying the stems occasionally with Paris green at this time. The moth very often deposits her eggs on the under or protected side of the plant so care must be used to apply the poison there also. Lime should be used as the vines are easily injured by the arsenites. The best remedy as far as I know is a repellant consisting of cobs, rags or sticks dipped in coal tar every few days and placed in a little row around the hills. The moth dislikes the odor and will not deposit her eggs on the surrounded plants. Planting summer squashes among the late varieties and then burning the early plants is a good protection for the late plants. No borers have yet been found in the State to my knowledge, but many supposed cases have proven to be the disease communicated by the striped cucumber beetle. For treatment of this disease, see "Striped Cucumber Beetle."

SQUASH BUG. (*Anasa tristis* De G.).

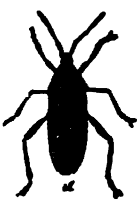


Fig 48.—
Squash Bug.

To growers of the squash this large brown stink bug is far from a welcome guest. It winters over as an adult under boards and in protected places, and with a hungry longing, it watches for the appearance through the ground of the squash vines, that it may again feed and be satisfied. While sucking the sap it breeds extensively on the plants as can be readily seen by the clusters of reddish brown eggs on the leaves and later by the young bugs.

Remedy.—This is one of the few insects for which we can suggest no better remedy than catching by hand and killing. We can kill the eggs and young bugs with kerosene emulsion, but it is the old bugs early in the season that do the most harm, and these are affected but slightly by this remedy. Hot water will kill the plants much quicker than the bugs. It has been proven in many cases that much of the injury attributed to the bug, has really been caused by some one of the hidden squash insects already spoken of or the squash vine disease. Care should therefore be taken to be sure what is doing the harm before treating.

DISEASE OF THE BEAN.

ANTHRACNOSE (*Glœosporium lindemuthianum*).

The spots upon the pods, stems and leaves of beans, particularly the wax-podded varieties, are commonly called "rust," but are really due to a species of anthracnose. At first it shows as a reddish-brown spot, but the center soon becomes white, finally turning to a light brown. The spots enlarge and if sufficiently numerous several of them will grow together and cover a large part of the surface of the bean pod or leaf.

Upon the pods the portion attacked soon sinks below the surface, and the disease may spread to the beans themselves, causing them to shrivel.

The disease is particularly troublesome in damp seasons, when grown in a low, moist place. If planted upon high, well-drained soil, where there will be a current of air, the danger of injury will be lessened.

The use of copper sulphate solution also seems to prevent the spread of the disease. It should be used very weak, not stronger than one pound to 500 gallons of water and will then do no harm, and with fairly favorable conditions will keep the beans practically free from disease.

INSECTS OF THE PEA AND BEAN.

PEA AND BEAN WEEVILS.

Although these insects belong to different species and always work in the seed of the one plant which the name indicates, yet their habits are alike, and the same treatment will kill one as readily as the other. The eggs are deposited by the beetles on the outside of the pod and when they hatch the young grub, while yet very small, gnaws through the pod into the young seed and there developes. The peas seldom contain more than one grub each, while a single bean may contain as high as twenty grubs. It is better not to plant "buggy" peas or beans if it can be avoided, even if the weevils are not alive in the seed. The germ is not usually destroyed by the weevils but the seed is weakened by the loss of what has been eaten from it.

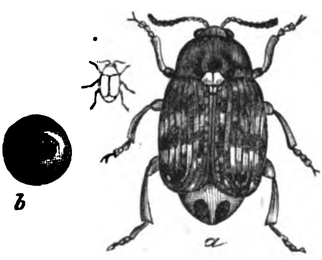


Fig. 49.—Pea Weevil. *Bruchus pisi.*

Remedies.—Place in a tight jar and use bisulphide of carbon, or immerse in hot water for a few minutes, or place in an oven for a short time and bake them, being careful that the temperature is not much above 145 degrees, Fahr. In separating "buggy" from sound peas drop into water, when the "buggy" peas will float and the sound ones sink to the bottom.

DISEASES OF THE TOMATO.

This plant is attacked by a number of diseases, which are commonly known as rots of the fruit and blights of the leaves. The form of rot caused by the fungus *Macrosporium solani* is perhaps most troublesome. While other fungi are often found associated with it, the most common form of rot, which so often appears at the blossom end of the fruit, is attributed to it. While some varieties are more subject to the attack of this disease than others, it seems most likely to appear upon plants that have been subjected to some kind of a check, and for this reason it is perhaps most prevalent in hot, dry summers although a cold, wet season seems to invite the development of the disease.

It shows at the point attacked as a greenish-brown spot, which gradually enlarges and may involve a greater part of the fruit. The diseased portion seems to sink below the surface of the surrounding healthy parts and the cuticle may turn yellow and finally white. If conditions are favorable, a crop of olive green spores will develop upon the diseased parts, by which the rot will be distributed.

By the use of Bordeaux mixture soon after the fruits have set, repeating it once at the end of two or three weeks, and if the rot still persists applying copper sulphate solution, the crop can be grown with but little danger from the rot. The frequent use of the cultivator, in dry seasons, will also lessen the check to the plants and the danger of attack by the fungus.

While it is not certainly known that the use of fungicides will prevent the blighting of the leaves, they seem to have a good effect, and may be found desirable for the purpose.

INSECTS OF THE TOMATO.

THE TOMATO SPHINX. (*Protoparce celeus* Hbn.).

The large green tomato worms frequently annoy people because of their great size and ugly appearance. They are perfectly harmless to handle, and because they are so readily noticed, picking them off by hand is the quickest and simplest remedy we can suggest. They are very hearty eaters and will quite often nearly strip the vines of their foliage. A cut of the three stages in its life history will show the stages of transformation of the sphinx. The pupa will often be plowed up when making garden in the spring. This jug shaped case should be destroyed when found.

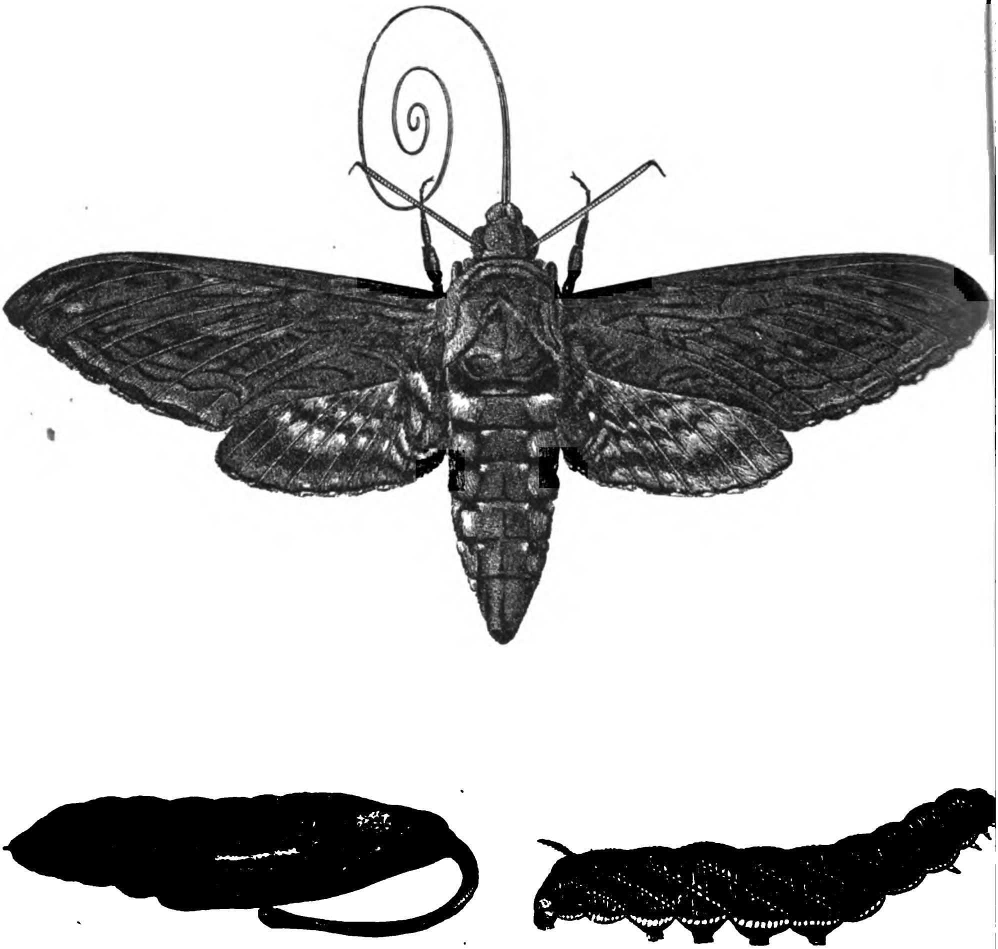


Fig. 50.—The Tomato Sphinx, showing larva, pupa and imago.

SPRAYING MACHINERY.

The treatment of orchards requires machinery adapted to the purpose, if it is to be performed profitably. While a small bucket pump will enable one to spray a few, small trees in the home garden, it does not do satisfactory work in large orchards, and for this purpose some of the more powerful barrel or tank pumps should be used. These should have large air chambers, which will enable them to throw even and continuous streams, and if the pump handle is geared to the wagon wheel extensive orchards can be sprayed very quickly and with but slight expense for labor.

Frequent inquiries are received as to the best pump for orchard spraying and to afford such information as is in our possession, upon this subject, we have concluded to insert illustrations and descriptions of some of the pumps and nozzles which we can recommend from our trials of them. The firms manufacturing them are some of the largest and best known in the country and will be found entirely reliable. The prices quoted are net for a single pump, but when three or more pumps are ordered at one time we have made arrangements with the firms by which a discount of fifteen to twenty-five per cent will be given if the cash is sent with the order. If several farmers in a neighborhood club together and send in an order, from two to four dollars can be saved upon each pump.

Among the latest candidates for public favor in the pump line are the Eclipse and Eureka spray pumps made by the Morrill & Morley Co. of Benton Harbor, Mich. The former pump is shown in Fig. 51. It is made in two styles; one has all its parts, except the handle, of brass, while the other has brass cylinder, piston and valves, with the remaining parts of iron. The first style sells at retail for $20, while the latter costs but $10. As will be seen, this pump stands low down in the barrel, so that there is but slight danger of its tipping over. It is also at such a height that it can be readily worked. The valves and plunger being of solid brass, without rubber or leather packing, the inventors claim that it will be much more durable and that there will be none of the vexatious delays that are so common with many of the other pumps. Being immersed in the spraying material, there is no necessity for a stuffing box, which is a necessary part of most of the other pumps, and which cause a considerable increase in the friction if tight, or allow the liquid to spurt out upon the man at the handle when loose.

The power is applied at the downward stroke, making it easier than in most pumps, while the small rod from the end of the handle works an agitator, which is quite efficient in keeping the material in suspension.

Another good feature of this pump is that the sliding plate which rests upon the top of the barrel allows the instant adjustment of the pump to any size of barrel or tank. While the brass pump is particularly desirable for the use of the clear solutions of copper sulphate, the heavy iron castings used in the combination pump will make it quite durable.

The Eureka is similar to the combination Eclipse except that it has two cylinders, which together have the same capacity as the single cylinder of the Eclipse. It has no agitator and requires an equal power upon both strokes. A larger sized pump of the Eureka pattern has long brake handles and two agitators. It can throw two large or four small streams and is adapted for work in large orchards.

Both of the above pumps have been used in the Station orchards and have given entire satisfaction.

The Church Manufacturing Co. of Adrian, Mich., have recently placed on the market a barrel pump, which is similar, except in size, to their bucket pump, shown in Fig. 60. It has several of the desirable features of the Eclipse and Eureka pumps and for a cheap pump (the price being only $8) it has many things to commend it.

Fig. 51.—Eclipse Spray Pump.

The Bean-Chamberlain Co. of Hudson, Mich., also make an excellent line of pumps, that have been in use for many years in the orchards of California, where they have given excellent satisfaction. The better forms for orchard spraying are mounted upon a platform and are designed to be placed in a wagon with several barrels of water from which the water can

be drawn by means of a hose. They have a cylinder that is lined with porcelain, which gives it a wearing power and enables it to withstand the action of the fungicides. The piston has an adjustable and very durable rubber packing. The water is forced into the large air chamber and is forced out in a continuous stream by the compressed air. This air chamber is of riveted steel and is galvanized upon the inside. In the various sizes of pumps, the air chamber varies in size from twenty to fifty inches in height and from two and one-half to eight inches in diameter. The size known as No. 1½ is suited for orchards of medium size and sells for about twenty dollars, including hose and nozzles.

The Field Force Pump Company of Lockport, N. Y., were among the first to place spraying pumps upon the market. Their 'Standard' spraying outfit (pump, hose and nozzle) costs with iron cylinder, plunger, etc., $8, and if brass $10. Their 'Perfection' outfit is more powerful and the cost is $9.50 and $12 respectively. It has a long discharge hose and also a return hose for keeping the spraying materials in suspension. These pumps have their cylinders above the barrel and on this account are less desirable than the Empire Spraying Pumps (Fig. 52) made by the same firm.

The single Empire with suction pipe, return pipe (agitator), 10 ft. of discharge pipe, graduating spray nozzle, and with iron cylinder, plunger and rod costs $8, or $10 with brass cylinder, plunger rod and valve seat. The double Empire (Fig. 52) is heavier, with a larger air chamber, etc., and has two discharge pipes and Vermorel nozzles. The price of this pump is $10 and $12.50 respectively for iron and brass cylinders, etc. As will be seen from the illustration, these pumps have their air chambers within the barrels, thus doing away with the objection urged against the 'Standard' and 'Perfection' outfits. They also have quite a long handle and are supplied with brass strainers over the suction pipes. The Field pumps use leather valves and have stuffing boxes.

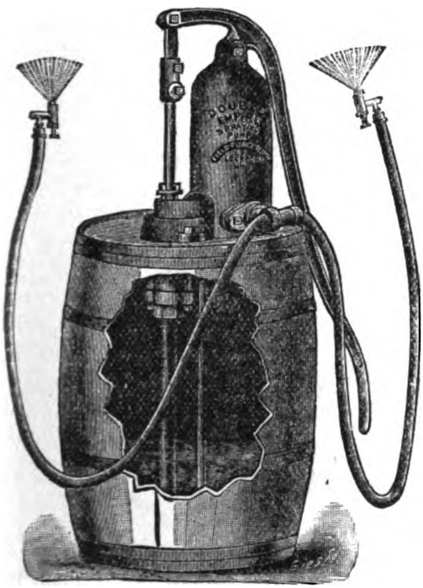


Fig. 52.—Empire Spray Pump.

The Gould Manufacturing Company of Seneca Falls, N. Y., are also well and favorably known. They make the 'Standard' Double Acting Spray Pump with brass cased plunger and brass lined cylinder which they furnish as shown in the cut (Fig. 53) with suction pipe, and two discharge pipes with nozzles, for $16.50, or with one discharge hose and nozzle for $13.50. This is a very powerful pump and as it is arranged to be fitted to the side of a barrel there is less necessity for having the cylinder inside. This pump is also made without the air chamber shown in the illustration, for one dollar less than the above prices. It, however, has a hollow plunger which to a certain extent serves as an air chamber. In a general

way the Gould pumps resemble those of the Field Company in their construction.

The Nixon Nozzle and Machine Company of Dayton, Ohio, manufacture the Climax spraying machinery. Their pumps are light but strong and well made. Their Climax Tripod pump (Fig. 54), has brass working parts. The No. 2 has one and one-half inch cylinder with four feet of suction hose, twelve and one-half feet of discharge hose and two Climax nozzles. No. 3 has a two-inch cylinder, suction hose, two lengths of discharge hose and four nozzles. They are supported upon a pipe tripod.

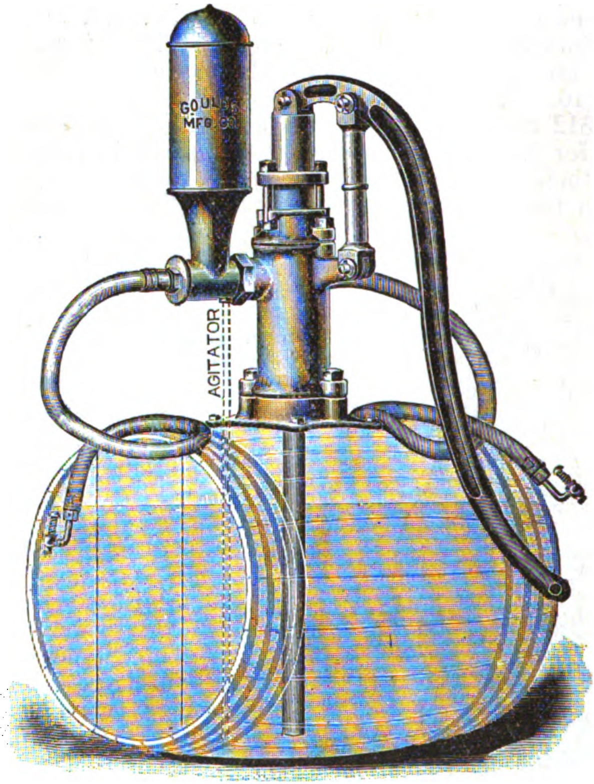


Fig. 53.—Gould Spray Pump.

The cost is $15 and $20 respectively. Either of the above pumps can be fastened to a barrel if desired, and an automatic agitator as shown in Fig. 55 can be added at an expense of one dollar.

For orchard spraying when the number of trees is not large any of the above pumps can be fastened to a barrel and by placing this in a wagon, or on a stone boat, the material can be readily hauled from tree to tree. For the spraying of grapes, raspberries and other small fruits the truck shown in Fig. 56, is a great convenience. The truck itself is well worth having as, when not in use for hauling the barrel, a cart body can be substituted for the latter and a very handy cart can thus be made. These trucks are sold both by the Field Company and by the Lansing Wheelbarrow Works.

Fig. 54.—Climax Tripod Pump.

Fig. 55.—Nixon Climax Pump with agitator.

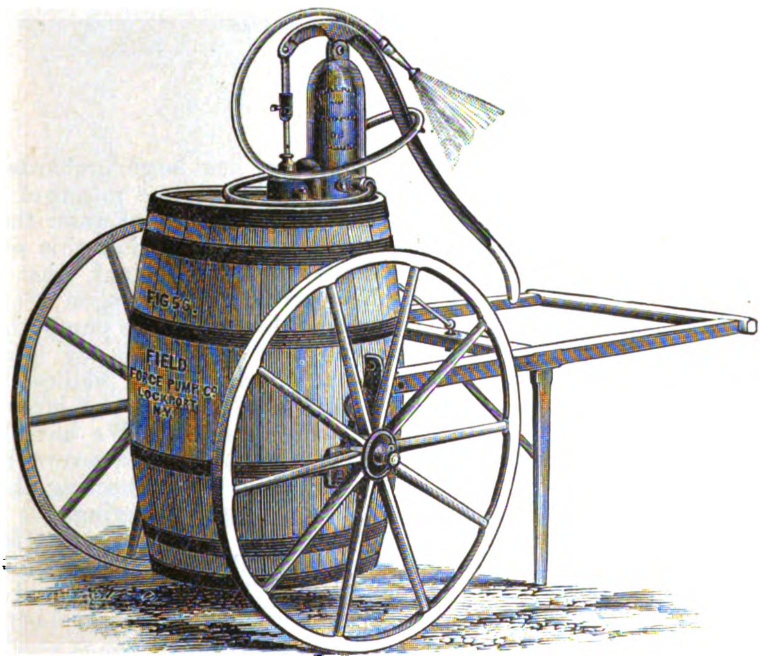


Fig. 56.—Barrel Truck for Spraying.

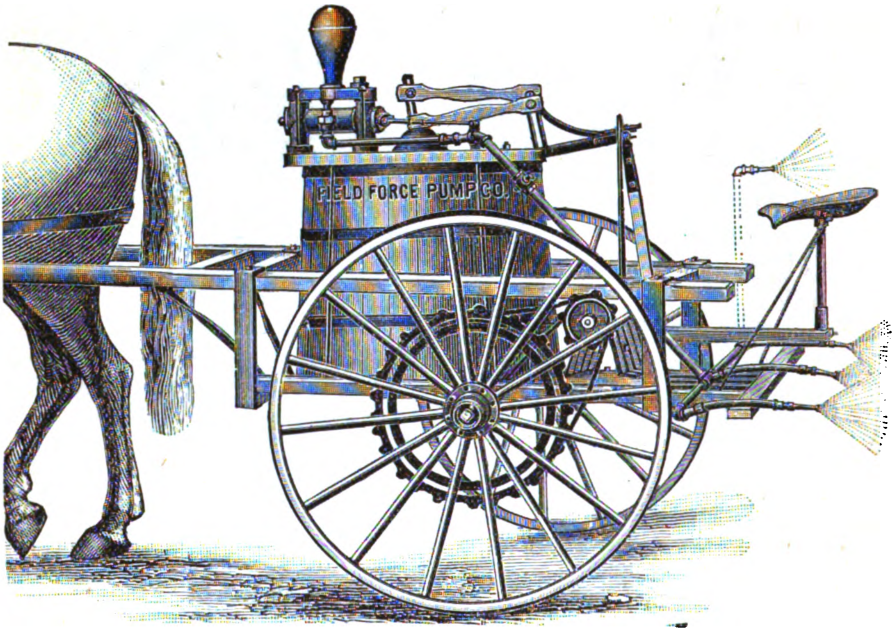


Fig. 57.—Victor Spraying Machine.

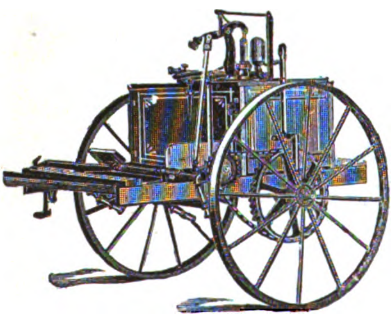


Fig. 58.—Nixon Spraying Cart.

When one has large orchards, it is desirable to have some means of carrying a larger quantity of water than can be taken in a barrel. For this purpose we have mounted a tank that holds twelve barrels upon a wagon gear, and by using a double acting pump that can be geared to the wheels by means of sprocket wheels and an endless chain, have been able to get over a large number of trees in a day. We have known of others who have placed several barrels in a wagon, and by connecting them by pipes, have thus been able to increase the rapidity of spraying.

Nearly all of the manufacturers of spraying machinery can furnish spraying carts. These are generally two-wheeled affairs to be drawn by one horse, with either a square or round tank. The pump is geared to the wheels by means of a sprocket wheel and endless chain.

Fig. 60.

In Fig. 57 is shown the Victor Spraying Machine made by the Field Pump Co., while the one furnished by the Nixon Co. is shown in Fig. 58. As will be seen from the illustrations, either of these machines can be used for the spraying of potatoes, strawberries and other low plants as well as orchard trees.

BUCKET PUMPS.

When one has only a few trees or plants in one's garden, some of the so called bucket or hand pumps will be found to do very good work. One of the best of these is made by the F. J. Myers & Bro., Ashland, Ohio. (Fig. 59). It is simple in construction and quite strong and durable, so that it is not likely to get out of order. Its air chamber capacity is ample and it throws a steady and powerful stream.

For use in a small garden or orchard, or about the house and stable, one of the most satisfactory pumps that we have seen is made by the Church Manufacturing Co., of Adrian. It works very easily and by means of its large air chamber (Fig. 60), throws a regular stream.

The Deming Co., of Salem, Ohio, also make an excellent bucket pump known as the "Success." Among the other manufacturers of bucket pumps are the firms mentioned above as manufacturers of orchard pumps and Wm. Stahl, Quincy, Ill., P. C. Lewis, Catskill, N. Y., and W. & B. Douglass, Middletown, Conn.

NOZZLES.

Fully as much depends upon the nozzle as on the pump, if one would spray successfully. The ideal nozzle is one that is not easily clogged and which if it does become stopped up can be readily freed from obstructions; for orchard trees it is desirable that it should throw a thin fan-shaped spray, while for bush fruits it is better if in the form of a fine mist. If possible it should be readily adjustable for either kind of work, and while not likely to get out of order, it should be so constructed that it can be readily taken apart. For orchard spraying, the McGowen nozzle, manu-

factured by J. J. McGowen, of Ithaca, N. Y., satisfies the above conditions. It has a plunger, that is adjusted by a set screw and controlled by a stiff steel spring; if in any way the orifice becomes clogged, the force of the water will push out the plunger against the spring, thus allowing the obstruction to pass out through the full sized opening. The size and character of the stream can also be varied at will. The price of this nozzle is two dollars.

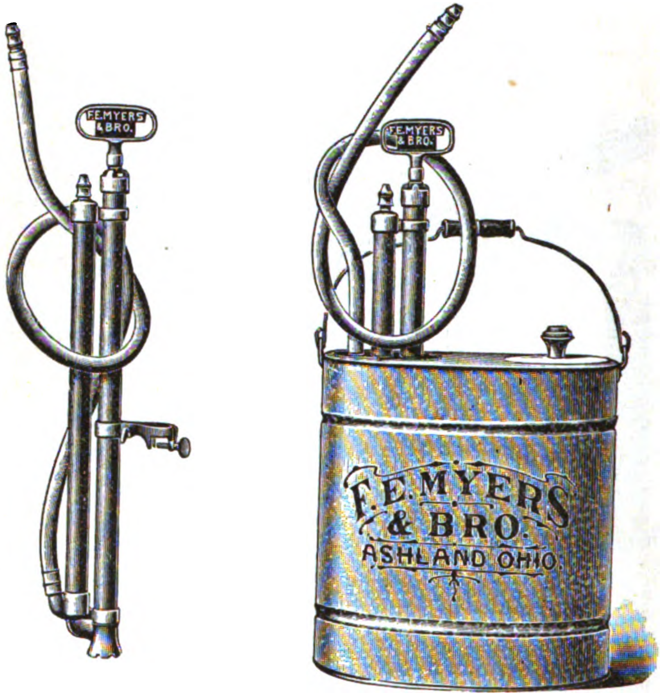


Fig. 59.—Myers' Bucket Pump.

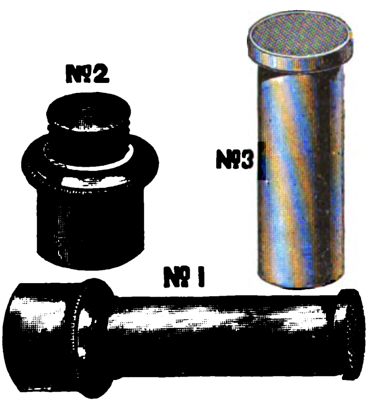


Fig. 61.—The Nixon Nozzle.

The Nixon nozzle (Fig. 61) consists of three parts, of which No. 2 is a nipple with a small perforation at the end, through which a solid stream is thrown, which finally breaks into a fine spray. The cap (No. 3) screws on over the end of the nipple, and has its end covered with fine brass netting which breaks up the stream into a mist-like spray. This nozzle does excellent work on low trees and on bush plants, but it is hardly satisfactory for use upon trees so tall that they cannot be reached with the spray through the netting. Another objection to this nozzle is that it is liable to clog, and yet, as stated above, for many purposes it is an excellent nozzle. It retails for one dollar.

The so called Vermorel nozzle (Fig. 62), as made by the Gould Company and others, is constructed on the same principle as the old Cyclone nozzle, with the addition of a degorger by which any small obstruction can be removed from the orifice. It is an excellent nozzle for Bordeaux mixture in particular, when small plants are to be sprayed, as its spray can only be equaled by that of the Nixon.

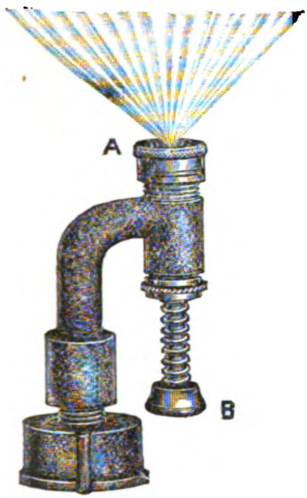


Fig. 62.—Vermorel Nozzle.

The Graduating Spray nozzle has been much used, and can be readily adjusted to throw either a solid stream or almost any kind of a spray. Its principal objection is that it readily clogs, and although by the removing of a screw it can be taken apart and the obstruction removed, it often causes a considerable delay, especially if a geared machine is used, as the hose may burst. Another objection to this nozzle, especially when small plants are to be sprayed, is that it is wasteful of material.

Fig. 63.—Graduating Nozzle.

The Boss nozzle was one of the first brought out and is still much used. It is shown in Fig. 64.

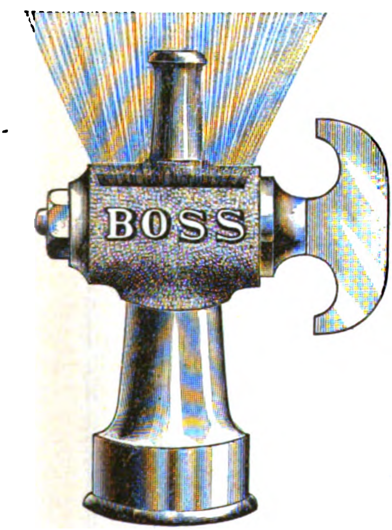


Fig. 64.—Boss Nozzle.

F. E. Myers & Bro., make a very ingenious nozzle, which can be adjusted at will, to throw any kind of a spray. The stream leaves the nozzle through a small, round hole and is thrown against a projecting portion of the nozzle, at any desired angle, and in this way the character of the spray can be varied. If the nozzle becomes clogged it can be freed from the obstruction in a simple manner. It is called the Bordeaux nozzle.

One of the best of the new nozzles for almost any kind of spraying is a modification of the Vermorel, made by the Bean-Chamberlain Company.

Instead of having a movable degorger, this nozzle has the degorger stationary and the obstruction is removed by pressing the end of the nozzle against a branch of a tree or some other object, and slipping it back against the degorger.

When using the nozzle at the end of an extension this makes the removal of the obstruction much simpler than in the old way.

The Myers Bros. also make a nozzle, shown in Fig. 65, which works well with solutions that are not likely to clog.

Fig. 65. Myers Bros.' Nozzle.

PIPE EXTENSIONS.

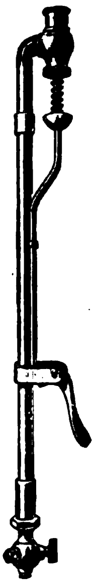


Fig. 66. Pipe extension.

Even when spraying low plants it is desirable to have at the end of the hose a short rod with the nozzle at one end and a shut-off valve at the other by which the stream can be cut off while passing from plant to plant, and whenever it may be desirable to stop spraying for a moment. In this way the material will be saved and the air pressure will be maintained so that there will be no loss of time when spraying is resumed.

A similar arrangement is particularly desirable when spraying tall trees, as in addition to the advantages mentioned above, by the use of a long piece of gas pipe with a valve at one end and the nozzle at the other, a fine spray can be carried to the top of the highest orchard trees.

In Fig. 66 will be seen a short lance, with a degorger for the removal of obstructions from a Vermorel nozzle, made by the Gould Manufacturing Co., which is very useful upon low plants. A pipe extension in two lengths, one or both of which can be used as is desired, made by F. E. Myers & Bro. is figured in Fig. 67. For the best work it should have a shut-off at the lower end. Better even than the gas pipe is the bamboo extension, which can be obtained in any length up to ten or twelve feet.

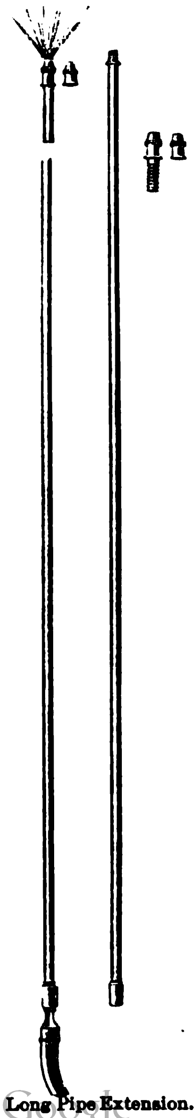


Fig. 67. Long Pipe Extension.

KNAPSACK PUMPS.

The so called knapsack pump consists of a copper tank holding four or five gallons, arranged with straps so that it can be attached to the back. The pump and air chamber are inside the tank. The atment of the handle and hose are shown in Fig. 68 which illustrates the Eclipse Knapsack sold by the Morrill & Morley Co.

Fig. 68. Knapsack Pump.

POWDER GUNS.

For the application of insecticides in a powder form some of the powder guns can often be used to advantage. Of these one of the best known is Leggett's Powder Gun, manufactured by Leggett & Co., New York, which is sold by most seedsmen. As shown in Fig. 69, it is provided with a number of attachments adapting it for use with a variety of plants. When carefully handled it will do good work, but it sometimes troubles by the breaking of the agitator owing to the packing of the powder. The Comet powder gun, made in New Haven, Conn., is constructed upon similar principles and has given even better satisfaction as used here.

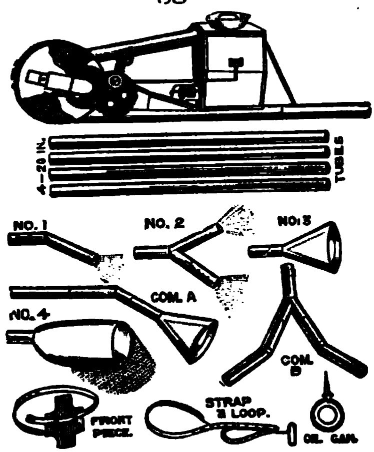


Fig. 69.—Leggett's Powder Gun.

Very simple contrivances are often used for application of the powder which do good work. It may be placed in coarse sacking or in muslin, but a more common form of powder distributer is the tin pail with a finely perforated bottom. If these are shaken over the plants, a fairly even distribution of the powder will be made, but it will not be applied as rapidly as with a powder gun.

AGRICULTURAL COLLEGE, MICH.,
March 31, 1895.

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MICHIGAN

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AGRICULTURAL COLLEGE, MICH.
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L. G. GORTON, *President of the College.*

F. B. MUMFORD, *Agricultural College, Mich.*

BULLETIN 122-123-124. APRIL, 1895.

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION.

HORTICULTURAL DEPARTMENT.

SMALL FRUIT NOTES.

NATIVE PLUMS AND RUSSIAN CHERRIES.

THE APPLE ORCHARD.

L. R. TAFT, H. P. GLADDEN AND U. P. HEDRICK.

AGRICULTURAL COLLEGE, MICHIGAN.
1895.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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SUB-STATIONS.

Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.

SMALL FRUIT NOTES.

BY L. R. TAFT AND H. P. GLADDEN.

The number of new varieties of fruits placed on the market each year is so large that individuals cannot afford to test them upon their own grounds and we have endeavored to keep our collection so complete that it would enable us to give information as to the relative merits of the different varieties to prospective planters. Not only do we have a duplicate collection upon the Sub-Station grounds at South Haven, but there are a large number of fruit growers in various parts of the State, who are aiding us by reporting the results obtained upon their grounds.

In many cases the varieties noted in this bulletin were sent here for trial by the originators and we are thus able to give information to would-be purchasers, as soon as they are placed upon the market.

STRAWBERRIES.

The soil upon which the strawberries have been grown is a sandy loam containing a considerable mixture of clay. The land was well enriched with stable manure the fall before the plants were set. (The plants were set in the spring of 1893 and most of the data were obtained from this setting, though another plat, containing most of the varieties noted, set the season of 1892, was kept for comparison.) A heavy mulch of straw and marsh hay was given the plants in the fall. The spring following, the mulch was moved to adjoining rows to permit of a shallow and thorough cultivation, then replaced as a mulch and to keep the berries from the ground. Early in the spring the plants were sprayed with Bordeaux mixture. Four applications were made, the last about two weeks previous to the ripening of the crop. The benefit of the sprayings was clearly shown in the almost entire absence of leaf blight on the plants treated; while plats purposely left unsprayed, for comparison, were badly affected with the disease.

The frequent and abundant rains occurring in the early part of the season gave the plants a vigorous growth. Nearly every variety blossomed full and set a large amount of fruit, but the protracted drouth soon coming on greatly lessened the yield.

TABLE NO. 1.—STRAWBERRIES.

ABBREVIATIONS.

Form.
b, broad. l, long.
c, conical. o, oval.
d, depressed. r, round.
i, irregular.

Size.
s, small.
m, medium.
l, large.

Color.
b, bright. l, light.
c, crimson. r, red.
d, dark. s, scarlet.

Variety.	Sex.	Vigor (1-10).	Date of bloom.	First ripe fruits.	Last fruits.	Productiveness (1-10).	Size.	Form.	Color.	Quality.	Firmness.
Accomac	b	8	May 8	June 12	June 27	6	m	l c	d c	9	7
Afton	p	7.9	" 8	" 11	" 28	9.6	m to l	r c	d c	9	8.8
Alabama	b	8.4	" 8	" 14	" 27	5	m	r c	d c	9	9.5
Alpha	b	8.5	" 8	" 13	" 27	8.5	m	c	l c	8	6
America	b	8.7	" 8	" 12	" 27	9	m	r c	b d s	9.5	9
Banquet	p	7.5	" 7	" 11	" 27	8.8	m	c	d c	9	7
Beauty	b	8.5	" 5	" 11	" 28	9	l	r b c	b d s	8.5	8
Beder Wood	b	9	" 5	" 11	" 27	9	s to m	r	l c	7	8
Belle	b	8	" 8	" 17	" 27	9	m to l	l c	b s	8	9
Belle of Lacrosse	p	8.1	" 8	" 12	" 28	9.8	l	r b c	b d s	8	8
Beverly	b	8.5	" 8	" 11	" 27	8.8	l	r c	d c	9.5	9.5
Bickle	p	8	" 8	" 12	" 27	9.5	s to m	r c	l s	7	7
Bird	p	9.2	" 5	" 12	" 28	9.5	l	l c	b d s	9	9.2
Bomba	b	7	" 6	" 11	" 28	8.5	m	c	d c	9	8.5
Bowman	b	7	" 11	" 12	" 26	6	l	r c	l s	9	7
Boynton	p	8	" 7	" 11	" 28	9.2	s to m	o	l c	8	8.5
Brandywine	b	9.9	" 12	" 14	" 29	9.4	l	r c	b d c	9.5	8.5
Brunette	b	9	" 11	" 12	" 26	9	l	r c	b s	9.8	9
Bubach	p	9	" 8	" 11	" 28	8.5	l	d c	l c	9	8
California	b	6	" 8	" 12	" 28	6	s to m	l c	b d s	9.5	9
Cameronian	b	9.8	" 5	" 12	" 28	7.5	m	r c	l s	7	7
Chairs	p	9.4	" 11	" 12	" 28	9.4	l	b c	b c	7	7.5
Charlie	p	9.3	" 18	" 14	" 28	7	m	l c	b d s	9	8.8
Cheyenne	p	6.8	" 11	" 18	" 28	8.8	m to l	l c	b s	9	8.5
Childs	b	8.8	" 8	" 12	" 28	9.6	l	d c	b c	9.5	9
Clark Early	b	6.6	" 7	" 6	" 28	8	l	r o i	d c	9	9
Clark Seedling	b	7.8	" 11	" 6	" 27	8	l	r c	d c	9.2	8
Clyde	b	8.9	" 6	" 13	" 27	9.5	l	r c	l s	9	8.5
Crawford	b	9	" 10	" 18	" 28	9	m	r c	s	9	9
Crescent	p	9	" 7	" 7	" 26	9.2	m	r c	l s	7	8
Dan Bisel	b	10	" 8	" 11	" 28	9.7	m	l b c	b c	9	9
Dew	b	7	" 10	" 14	" 30	7	l	i	d c	8	9
Dutter	b	8	" 8	" 18	" 29	8	l	l c	b s	9	8.5
Eclipse	p	8	" 8	" 12	" 27	6	s to m	o	l c	8.5	7.5
Edgar Queen	b	8	" 8	" 13	" 27	9	m to l	i r c	l c	7	8
Edward's Favorite	b	6.5	" 18	" 14	" 28	9.4	l	r c	b d c	9.4	9
Enhance	b	8.9	" 8	" 12	" 28	9.5	l	i r	d c	9	9
Epping	p	9	" 8	" 11	" 27	9.5	l	r d c	l s	8	9
E. P. Roe	b	7	" 7	" 17	" 27	2	l	b c	s	8.5	8
Eureka	p	8	" 10	" 13	" 29	8	m	r c	d c	7	8
Fairmount	b	8.5	" 11	" 12	" 28	9	l	d c	d c	9	7.5
Gandy	b	9.5	" 16	" 16	" 28	8.5	l	r b c	l s	9	8
General Putnam	p	8.5	" 7	" 17	" 26	8.5	m	r	l s	8	8
Glenfield	b	8.6	" 7	" 11	" 27	8	m	l c	d c	9	7
Great Pacific	p	8	" 11	" 14	" 27	8	m s	d c	r	9	8
Greenville	p	8.6	" 8	" 11	" 27	9.6	l	r d c	b c	8	7
Gypsy	p	7.6	" 11	" 11	" 28	9	m	r c	d c	9	9
Harmon	b	8.4	" 7	" 10	" 28	4	l	r c	v d c	8.5	8
Hattie Jones	p	8.4	" 12	" 18	" 29	9.5	m to l	r d c	l s c	6	7
Haverland	p	9.4	" 6	" 11	" 27	9.5	m	l c	s	8	8
Hermit	b	8.5	" 6	" 11	" 28	9.2	l	r c	d c	8	8
Hoard	b	8.5	" 8	" 12	" 26	9	m to l	r c	l c	8	8
Hunteman	p b	8.9	" 12	" 12	" 28	9.2	l	r c	d c	9	8
Hyslop	b	9.8	" 6	" 4	" 24	4	s	i	d	8.5	8.7
Iowa Beauty	b	8	" 8	" 11	" 28	8.8	l	r c	d c	9.8	8.5

TABLE No. 1.—STRAWBERRIES.—CONTINUED.

Variety.	Sex.	Vigor (1-10).	Date of bloom.	First ripe fruits.	Last fruits.	Productiveness (1-10).	Size.	Form.	Color.	Quality.	Firmness.
Jay Gould	p	9.3	May 10	June 1	June 28	9.2	m	r c	b c	9.2	9
Jessie	b	9	" 9	" 13	" 30	8	m to l	r c	d c	7	9
Jones Seedling	b	8.3	" 7	" 11	" 28	9	l	d c	d c	9	8.5
Judsonia	b	8.8	" 16	" 13	" 26	8.8	l	r b c	l c	7.5	7
Katie	b	9.1	" 10	" 12	" 28	8.8	l	r d c	c	8.5	7.5
King No. 2	b	9	" 6	" 11	" 27	7	m	r c	l c	8	8
Klickita	p	8.4	" 9	" 16	" 28	9.5	l	r d c	d s	9	7.5
Leader	b	7.3	" 5	" 11	" 26	8.2	m to l	l c	v d c	9	9
Leroy	p	9.8	" 8	" 12	" 28	9.8	l	d c	d c	9	9
Leviathan	b	7.2	" 10	" 14	" 29	8	l	b d	l s	8.5	9
Lida	p	8.9	" 8	" 11	" 28	8.8	m	r c	b c	8.5	8
Lillie Monroe	b	8.4	" 8	" 12	" 26	4	l	d c	d s	8	7
Lincoln	p	8.6	" 10	" 11	" 26	9.7	m	r d c	b s	8	9
Long John	b	8.6	" 8	" 11	" 27	9.4	m to l	v l c	b c	9	8.5
Lovett	b	7.3	" 6	" 11	" 27	8	m	r c	b c	8	9
Lower	b	8.8	" 8	" 12	" 27	7.5	l	r c	d s	8	8
Luther	b	8.3	" 8	" 11	" 26	6	s to m	l c	b s	9.5	8.5
Magnate	p	8.6	" 8	" 13	" 30	9	m to l	l c	b s	9	9
Michel	b	7	" 8	" 9	" 26	6	s	c	b s	7	7
Middlefield	b	8.5	" 6	" 12	" 30	7.5	m	c	c	9.5	9
Miner	b	9.5	" 7	" 11	" 27	8.7	l	c	d s	8	7
Moore Early	b	8.8	" 6	" 11	" 30	8	m to l	b c	b s	8	8
Mrs. Cleveland	p	9	" 6	" 11	" 28	9	m	r b c	b s	8	8
Muskingum	b	9	" 10	" 14	" 30	9	m to l	d c	d r	8.5	8
Mystic	b	9.3	" 6	" 15	July 1	8.5	m to l	r c	b d c	9	8
Neptune	p	6.7	" 15	" 12	June 26	9	m to l	r c	d c	7	7
Nim's Seedling	p	8.8	" 18	" 15	July 2	9.8	l	r c	b s	9.2	7.5
No. 1 (Allen)	p	8.7	" 12	" 11	June 27	6.5	m	r c	b c	9	8.5
No. 3 "	b	9.4	" 11	" 18	" 28	8	l	r c	b c	9	8.5
No. 5 "	p	8	" 8	" 12	" 30	9	m to l	r d c	v d c	9.5	8.5
No. 6 "	p	9.5	" 11	" 11	" 26	7	l	r c	d c	9.8	9
No. 13 "	p	8.9	" 8	" 11	" 27	9.5	m to l	r d c	v d c	9	9
No. 14 "	p	8.2	" 10	" 12	" 26	8	m	l c	l s	9	7.5
No. 2 (Belt)	b	9.5	" 11	" 14	" 29	9.2	l	c	b l s	9	8
No. 2 (Cameron)	b	7.8	" 10	" 13	" 27	9.4	l	l c	b c	9	9
No. 6 "	p b	9.5	" 11	" 14	" 30	8.7	l	r c	b s	9	7.5
No. 13 "	p	8.4	" 17	" 16	July 2	8.5	l	r c	d c	7.5	8
No. 1 (Engle)	b	9	" 15	" 16	" 1	8	m to l	i r	l c	8	8
No. 2 (Feicht)	b	4.5	" 8	" 12	June 27	9.2	l	r c	c	9	8
No. 3 "	p	9	" 8	" 14	" 29	9	l	i c	l c	8.8	8
No. 31 (Haynes)	p	8.5	" 8	" 13	" 27	6	l	i r c	b s	7	7
No. 2 (J. S.)	b	8.6	" 8	" 14	" 27	3	l	r c	c	8	7.5
No. 4 "	p	8.5	" 8	" 11	" 27	9.4	l	b c	d s	8.5	9.5
No. 6 "	p	8.5	" 11	" 14	" 28	9.6	l	r c	b d s	7	6
No. 18 (Little)	b	8.8	" 7	" 13	" 26	6	m	r c	b d c	8	9
No. 26 "	b	9.2	" 8	" 29	July 7	9	l	i	b d s	9	8
No. 42 "	b	8.8	" 11	" 14	June 28	9	l	r c	d c	9.5	8.5
No. 1 (Boser)	b	9.5	" 8	" 11	" 28	9.5	m to l	r c	d c	9.5	7.5
No. 1 (Stayman)	p	8	" 15	" 10	" 26	9.5	m	r c	l s	8	8
No. 24 (Thompson)	p	8.8	" 12	" 12	" 28	5	m	r c	b c	8	8
No. 64 "	b	8	" 11	" 11	" 28	9	m to l	i r c	b d s	8.5	9
No. 77 "	b	8.5	" 10	" 9	" 23	9.5	s	l c	b c	7	5
Odessa	p	8.8	" 19	" 14	" 29	9	v l	r or b c	l s	8	7.5
Ohio Centennial	p	9	" 19	" 16	July 1	9	l	b c	d s	9	8.5
Ohio Monarch	b	8	" 19	" 14	June 27	5	l	l c	b s	9	8
Ontario	b	9.4	" 19	" 17	" 29	9.4	m to l	c	l c	9	8.5
Parker Earle	b	8.5	" 8	" 13	" 28	9	m	l c	d s	8	9
Pawnee	b	8.5	" --	" 11	" 27	6	l	r c	d c	8	8.5
Primate	b	8	" 9	" 15	" 27	8.2	l	l c	d c	9.2	9
Princeton Chief	p	9.1	" 11	" 17	" 27	8.8	l	l c	d c	8.5	8.8

TABLE No. 1.—STRAWBERRIES.—CONTINUED.

Variety.	Sex.	Vigor (1-10).	Date of bloom.	First ripe fruits.	Last fruits.	Productiveness (1-10).	Size.	Form.	Color.	Quality.	Firmness.
Princess	p	7.5	May 7	June 11	June 26	5.3	m	r	s	9	8.5
Sadie	p	7.8	" 7	" 4	" 27	8.8	m	r c	d c	9	8
Sandoval	b	8	" 11	" 12	" 28	9	l	r c	v d c	8.5	9
Saunders	b	9.4	" 11	" 18	" 30	8	m to l	l c	b s	7	8
Seedling B	p	9.7	" 11	" 11	" 28	9.4	l	r c	s	7.5	7
Sharpless	b	9.2	" 11	" 12	" 28	8	m	b c	b c	8	8
Smeltzer's Early	b	9	" 8	" 11	" 26	5	l	r c	d c	9	8
Southard	b	8.3	" 6	" 18	" 27	8.5	m to l	r c	d s	8.5	8
Standard	b	8.2	" 8	" 11	" 27	8.8	l	r c	d c	9	8
Stevens	b	7.6	" 11	" 11	" 27	7.5	m	r c	d c	9	8
Stimmel No. 15	p	9	" 10	" 9	" 26	8.5	m	b c	l s	9	8
Stimmel No. 20	p	8.5	" 11	" 11	" 26	6	s to m	l c	d c	9	8
Surprise	b	8.5	" 7	" 11	" 28	8.5	l	l c	b s	8	8.5
Swindle	p	8	" 7	" 11	" 29	9	m to l	r c	c	7	9
Tom Walker	p	8.3	" 7	" 11	" 27	9	l	r c	d c	9	8
Topeka	b	8.5	" 8	" 18	" 28	8.5	m to l	l c	d c	8	8.5
Van Deman	b	7	" 5	" 4	" 27	6	m	r c	l c	8	8
Westbrook	p	7.5	" 6	" 13	" 26	4	s	c	d c	7	8.5
West Lawn	p	8.8	" 11	" 14	" 27	8	m	l	d s	6	8
Weston	p	9.5	" 14	" 18	" 30	9.8	l	b c	b s	8	8.5
Williams	b	8.7	" 14	" 18	" 28	9.4	m to l	r c	d c	8.5	9.3
Wilson	b	8.4	" 12	" 11	" 30	8	m	c	d c	8	9
Woolverton	b	9.4	" 9	" 11	" 29	8.5	m	l c	d c	8	9
Wyoming	b	7.8	" 10	" 18	" 29	8.5	l	r c	l s	9	9

NOTES ON VARIETIES.

The following varieties fruited for the first time the past season:

America.—Plants from Cleveland Nursery Co., Rio Vista, Va. The plants are of fair growth, but make few runners. A large amount of fruit set for growth of plants. The berry is of very handsome appearance and regular form. It is of high quality and sufficient firmness to make a good shipper.

Bird.—Plants from W. F. Bird, Ann Arbor, Mich. The plants are of strong, vigorous growth, sufficient to ripen a large amount of fruit. The crop was at best June 21. The berry is large, long conical in shape and of bright, dark scarlet color; seeds prominent and flesh firm, making it an excellent berry for shipping. It is of good quality. A promising sort.

Bowman.—Plants from Cleveland Nursery Co. The plants did not start well after setting and made few runners. The berry is large, round conical, of good quality, but not firm. The light scarlet color and lack of firmness are against it.

Brandywine.—Plants from Edward T. Ingraham, West Chester, Pa. The plants are of very vigorous growth, set and ripened a large amount of fruit. The crop was at its best June 22. The berry is very large, round conical, dark crimson color and of very high quality. The berries are lacking in firmness and often the large ones are hollow. Promising for home use or near market.

Chairs.—Plants from J. T. Lovett, Little Silver, N. J. The plants are of strong growth, healthy and productive. The fruit is of good size and fine appearance but is somewhat lacking in quality and firmness.

Charlie.—Cleveland Nursery Co. Plants of strong growth; blossomed full but did not set much fruit. Fruit of medium size, regular form, good appearance, of excellent quality and quite firm. The variety is lacking somewhat in productiveness, but is well worthy of trial.

Childs.—Plants from Matthew Crawford, Cuyahoga Falls, O. Plants of medium growth, blossomed very full and set a large amount of fruit. Crop at best June 21. The fruit is large in size and of a bright crimson color. Its productiveness, handsome appearance, high quality and firmness promise much for it as a valuable market variety.

Dan Bisel.—Plants from Dan Bisel, Tonti, Ill. No variety exceeds this in vigor of growth and plant producing qualities. Crop at best June 18. The plants are very productive. The form is somewhat irregular but the quality is good and the berries are firm. Very promising as an early market sort.

Jay Gould.—Plants from Chas. A. Green, Rochester, N. Y. Plants are of good growth. Crop at best June 20. The plants are productive; the berry of good size, regular form, high in quality and quite firm. A promising market berry.

Judsonia.—Plants from John Little, Granton, Ontario. The plants are of fair growth and moderately productive, but the berries are light colored and lacking in quality and firmness.

Long John.—Plants from Thomas Wilde, Herrington, Mich. The plants grow vigorously in hills, but produce very few runners. Crop at best June 22. The fruit is of good size, very long conical form and of bright crimson color; the quality is good and the berry is moderately firm. The hills produce a large amount of fruit. The variety is difficult to propagate.

Luther.—Plants from W. F. Allen, Jr., Salisbury, Md. Plants are of medium growth. The fruit is of high quality and moderately firm but the plants were lacking in productiveness.

No. 5 (Allen).—Plants from W. F. Allen, Jr. Plants are not of strong growth. The berry is of good size and regular form. The color is dark crimson and the quality excellent. Its handsome appearance and high quality make it desirable for home use. The plants are moderately productive.

No. 6 (Allen).—The plants are of strong growth but did not set much fruit. The berry is large in size, handsomer in appearance and better in quality than No. 5, but not as productive.

No. 13 (Allen).—Plants are of good growth, blossomed full and set a large amount of fruit. Crop at best June 20. Fruit of good size, fine appearance, regular form, good quality and firm. Productive. Perhaps the best of Allen's tried here and a very promising sort.

No. 14 (Allen).—Plants are not of very vigorous growth. Berry medium in size, long conical with neck, light scarlet color, quality good. The plants lack in productiveness and the berry rather soft and light colored.

No. 1 (Roser).—Plants from E. L. Roser, Brittain, Ohio. Plants of strong growth. Crop at best June 23. Fruit of good size, attractive appearance and high quality, but not very firm and the berries are often hollow. Productive.

No. 64 (Thompson).—Plants from Cleveland Nursery Co. Plants of medium growth but set well with fruit. Crop at best June 23. Fairly

productive. The berry is irregular in form, often coxcombed. The fruit ripens unevenly and often has a hard core.

Princeton Chief.—Plants from Slaymaker and Son. Plants of medium strong growth. Crop at best June 21. Fruit uniformly large in size, long conical form and of good appearance. Medium in quality, firmness and productiveness. The berries usually have a hard core.

Sandoval.—Plants from Matthew Crawford. Plants of medium growth. Fairly productive. Berry large in size, good form, firm and quite handsome in appearance. A berry of fair promise.

Seedling B.—Plants from J. Little. Plants of very strong growth, healthy and productive. The fruit is large in size, but the color is light and the berry lacks in quality and firmness.

Bulletin No. 100 published in August, 1893, contained notes on eighty new varieties of strawberries. Another season's trial of these sorts, during which the original plants set in 1892 and a new setting in the spring of 1893 have fruited, should give data sufficient to form a fair idea of their respective merits or demerits.

Of the eight varieties placed in Group 1, as possessing points of superior excellence and deserving of a place among the best sorts, *Clyde*, *Greenville*, *Leroy* and *Weston* are all that is claimed. *Clyde*, *Leroy* and *Weston* are very productive, the berries are of good form, handsome in appearance and firm enough to stand shipment well.

Greenville, while well up in other qualities, is scarcely firm enough to carry well; it is, however, an excellent near market berry. *No. 2* (*Feicht*) and *Topeka* (*Stayman No. 3*) are excellent sorts and well worthy of trial as home market berries. A further trial is necessary to fully determine their place. The light color of the *Epping* (*Yankee Doodle*) detracts from its appearance as a market sort, otherwise the variety ranks high.

Allen No. 1 is attractive in appearance and of high quality, but the past season's mark was far below that of the previous year in productiveness.

Several varieties placed in Group II, as having many points of merit but requiring further trial to determine their place, have proved worthy of special mention.

Afton is a promising market sort. The berry is of handsome appearance, good quality and firm. The plants are strong, healthy and very productive. It well deserves a place among the best sorts.

Belle of Lacrosse has again shown itself to be among the first in productiveness. The plants are strong growing and healthy. The berry is medium in quality and firmness. An excellent near market sort.

Brunette, because of its fine appearance and very high quality well deserves a place in every garden. It is fairly productive and the fruit is quite firm.

Iowa Beauty is another sort valuable for table use, though the berry is not as firm nor the plants as productive as Brunette.

Huntsman is productive and strong and healthy in plant growth. The fruit is attractive in appearance and of good quality. Were the berries firmer it would be an excellent market variety. It is worthy of trial for local market.

No. 2 Cameron shows up well as a market berry. The plants are not very strong growing but bear a good crop. The fruit is of good quality and firm.

No. 4 J. S.—Last season this variety did not show more than average merit. This year it was exceeded by few sorts in productiveness. It

possesses all other qualities necessary and should it continue to be productive it would be a most valuable market berry.

Weston.—By an oversight Weston was not included in the planting made two years ago. In the old patch (second year fruiting) the plants were remarkably free from blight and the most vigorous in the plantation.

Williams.—Last year the plants rusted badly. This season the plants were sprayed and the variety made an excellent showing as a market sort. Its good points are productiveness, firmness and attractive appearance.

The following varieties have much of promise in them, but further trial is needed before determining their place:

Banquet,	Hermit,	Nos. 26 and 42 (Little),
Beverly,	Leader,	Odessa,
Bickle,	Lincoln,	Primate,
Clark,	Nim's Seedling,	Standard.
Gypsy,	No. 3 (Belt),	

The following list includes sorts that have some good points, but they are so deficient in others that there is little hope of thoir ever occupying a prominent place among the standard varieties:

Accomac,	Leviathan,	No. 18 (Little),
Alabama,	Magnate,	Pawnee,
Cameronian,	Mystic,	Southard,
Clark Seedling,	Neptune,	Stevens,
Cheyenne,	No. 3 (Allen),	Smeltzer's Early,
Fairmount,	No. 6 (Cameron),	Surprise,
Glenfield,	No. 13 (Cameron),	Westlawn,
Hattie Jones,	No. 3 (Feicht),	Wyoming.
Katie,		

The varieties named below have little or no merit and will be placed in the rejected list:

California,	E. P. Roe,	Nigger,
Dayton,	Harmon,	No. 1 (Engle),
Dr. Moriare,	Hyslop,	No. 31 (Haynes),
Estelle,	Lillie Monroe,	Ohio Monarch.

A few brief notes upon the comparatively new, yet longer tested sorts should be given. The reader is referred to the table for further data concerning their qualities.

Beder Wood, in vigor of plant growth and productiveness, is exceeded by few varieties. It is the equal of Crescent in firmness and quality. The flowers produce an abundance of pollen; it is therefore an excellent pollenizer for the early pistillate sorts.

Belle, Gen. Putnam, Hoard, Muskingum, Swindle and Woolverton have proved themselves valuable market sorts. Woolverton is especially valuable as a pollenizer for the later pistillates.

Edgar Queen and Mrs. Cleveland are vigorous and healthy in plant growth, are productive and the fruit is of fair quality. In planting for local market they might profitably have a place.

Enhance as a berry for either local market or shipping purposes stands well toward the head of the list. Its irregularity of form and not ripening well at the tip are its only bad qualities.

Parker Earle, under high culture and in a favorable season, is likely to be the most profitable variety that could be selected for market purposes. It is not a good plant producer and the plants often lack sufficient vigor to ripen the large crop of fruit.

Sadie, and Stayman No. 1 are well worth a place in the home garden or for near market.

The old varieties, Bubach, Crescent, Haverland, Warfield and Wilson, are still the choice of the great majority of the growers for market purposes. Perhaps the time is near at hand when the Crescent and Wilson will be superseded by the newer sorts, Bubach, Haverland, Parker Earle and Warfield.

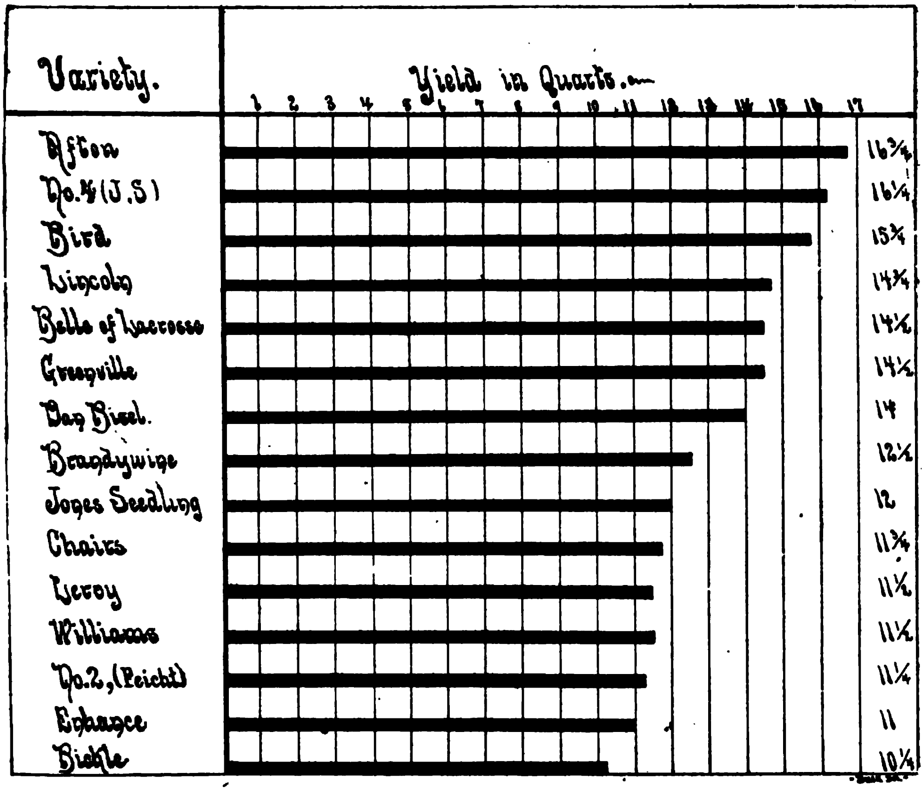
As pollenizers for the pistillate varieties, Cumberland, Miner and Sharpless are the most commonly used, though Beder Wood and Woolverton might be a better choice.

In the table below is given the date of picking and the quarts picked of fifteen of the more productive sorts among the newer varieties. By dividing the season into two periods and giving the yield for each division of time, an attempt has been made to show which are valuable as early varieties:

TABLE NO. 2.—YIELD FROM 40 FEET OF ROW, IN QUARTS.

Variety.	June 12.	June 14.	June 16.	June 18.	Total yield, June 12-18.	June 19.	June 20.	June 21.	June 22.	June 23.	June 25.	June 27.	Total yield, June 19-27.	Total yield for season.
Afton	¾	3	----	6	9¾	----	----	4	2½	----	½	----	7	16¾
Belle of Lacrosse	----	----	----	1¼	1¼	----	1½	----	5¾	----	4½	1½	13¼	14½
Bickle	----	1	----	5	6	----	1	¾	2	----	1	----	4¾	10¾
Bird	----	½	----	5	5½	----	1½	2¼	4	----	1½	1	10¼	15¾
Brandywine	----	----	1½	3½	5	----	1¾	----	3¼	----	2	1½	7½	12½
Chaire	½	¼	----	7	7¾	----	1	----	2½	----	½	----	4	11¾
Dan Bisel	½	½	4	5½	10½	----	2½	----	1	----	----	----	3½	14
Enhance	----	----	4	----	4	----	3½	2½	1	----	----	----	7	11
Greenville	----	2½	----	4½	7	----	3	----	1½	----	2½	½	7½	14½
Jones' Seedling	1½	1½	----	6½	9½	----	----	1¼	¼	----	1	----	2½	12
Lincoln	½	1¼	----	7	8¾	----	2	----	----	----	3	1	6	14¾
Leroy	½	----	----	4	4½	----	3½	----	2½	----	1	----	7	11½
No. 2 (Feicht)	1		----	4½	5½	----	2½	----	2¼	----	1	----	5¾	11¼
No. 4 (J. S.)	¼	2½	----	6	8¾	----	3½	----	1½	----	2½	----	7½	16¼
Williams	----	----	1½	----	1½	2½	----	3¾	----	2¾	----	1	10	11½

The diagram below shows at a glance the relative productiveness of the varieties in the above table.



RASPBERRIES.

The raspberries suffered much from the dry weather and severe heat during the ripening season. The bearing period was so shortened by the drouth that the dates of last ripening of fruits is omitted.

BLACK AND HYBRID RASPBERRIES.

ABBREVIATIONS.

Size.	Form.	Color.	
s, small.	r, round.	b, black.	g, glossy.
m, medium.	c, conical.	p, purple.	l, light.
l, large.	o, ovate.	o, orange.	pu, pubescent.

Variety.	Vigor (1-10).	Date bloom.	First ripe fruits.	Productiveness (1-10).	Size.	Form.	Color.	Quality.
Ada	9.2	June 5	June 30	8.5	m	r	g b	8
Caroline	9.5	" 4	July 1	7	m	r	l o	8
Columbian	9.5	" 14	" 14	9.5	l	r o	p	8.5
Conrath	9.5	" 4	June 30	9	l	r	b	8
Cromwell	9.	" 2	" 27	7.5	m	r	b	8
Ebon Beauty	8.5	" 4	" 29	7	m	r c	b	8
Farnsworth	9	" 2	July 1	8.5	l	r	b	8.5
Gregg	9.5	" 4	" 4	8.5	l	r	b pu	7
Hopkins	8.5	" 5	June 29	8	m	r	b	8
Jackson's May King	9.	" 2	" 28	7.5	s	r c	b	8.5
Johnston Sweet	8.5	" 4	" 30	7	m	r	g b	8
Kansas	9	" 3	" 28	8.5	l	r	g b	8
Lovett	8.8	" 2	" 29	7.5	m	r	b	9
Nemaha	9.2	" 4	July 3	8.5	l	r	b pu	7
Norfolk	8	" 2	June 29	6	s	r	b	8.5
Ohio	9.5	" 4	" 30	8.5	l	r	b	6
Older	9.2	" 1	July 2	9.5	l	r	b	9
Palmer	8	" 1	June 28	8.5	m	r	b	8.5
Progress	8	" 1	" 27	7	m	r	b	8.5
Shaffer	9.4	" 7	" 30	7.5	l	r o	p	8.5
Smith (Prolific)	9.5	" 4	July 1	9	l	r	b	9
Surrey	9	" 2	" 2	9.2	l	r	b pu	8.5
Virginia	9.4	" 2	June 28	8.5	l	r c	b	8.5
Winona	9	" 2	" 28	6.5	m	r	b	8
Wonder	8.5	" 3	" 29	7	s	r	b	8

NOTES ON VARIETIES.

Ada.—The bush is quite vigorous and bears a moderate crop of good sized berries.

Columbian Red.—This was the latest variety to ripen fruit. The canes are of strong growth, and healthy. The berry closely resembles Shaffer, but is firmer and of better quality. The bushes were productive. A promising variety.

Conrath.—The vigorous cane growth, productiveness and large size of the berries make this sort one of the most promising black-caps.

Cromwell.—A desirable early ripening variety.

Farnsworth.—The plants are vigorous, healthy and productive. The berry is large, firm and of good quality. Promising as a variety for home use or market.

Kansas.—Lacks hardiness. The canes are of quite vigorous growth and moderately productive. The fruit is of large size.

Lovett.—Not likely to occupy a prominent place among the newer early ripening sorts.

Norfolk.—Did not do well the past season.

Older.—Bush of vigorous growth and productive. The fruit is of large size, rather soft but of high quality. A promising sort for home use.

Palmer.—A good early market variety.

Progress.—Similar to Palmer, but the bushes are not so productive.

Smith (*Prolific*).—The bushes are of strong, vigorous, healthy growth. The berry is large, jet black, not very firm, but of good quility. A promising variety.

Surrey.—Bush of vigorous growth, and quite productive. Fruit resembles Gregg, but is not so late in ripening. Promising.

Virginia.—Bush a vigorous grower, hardy and productive. A promising early ripening sort.

Gregg and *Nemaha* are among the best late market sorts.

Ohio is one of the best medium season market sorts. It is very hardy and productive. It is the leading variety for evaporating purposes.

Shaffer.—For canning and home use this variety has no superior among the better known sorts.

Ebon Beauty, Jackson's May King, Wonder and *Winona* have not been sufficiently tested here to judge of their merits.

RED RASPBERRIES.

ABBREVIATIONS.

Size.	Form.	Color.	
s, small.	r, round.	d, dark.	o, orange.
m, medium.	c, conical.	r, red.	b, bright.
l, large.	o, ovate.	p, purple.	

Variety.	Vigor (1 to 10).	Date bloom.	First ripe fruit.	Productiveness (1 to 10).	Size.	Form.	Color.	Quality.
Arnold	9	June 5	July 4.	5	v l	o	b r	9
Belle de Fontenay	6	" 8	" 3.	8	l	r c	b r	9.5
Brandywine	8.5	" 7	" 4.	6	m	r o	d r	8.5
Cuthbert	9.5	" 7	" 4.	9	l	r o	r	8
Gladstone	8.5	" 6	June 30.	5	s	r c	d pu	8
Golden Queen	9	" 8	July 1.	6.5	l	r c	o	9.5
Hansell	8	" 4	June 28.	7	m	r	d r	9
Herstine	7.5	" 7	" 28.	6	m	r	b r	9.5
Lost Rubies	8	" 8	" 28.	6	l	r c	b d r	9.5
Marlboro	8.5	" 6	" 30.	7	m	r	r	8.5
Michigan Early	9	" 2	" 26.	8	m	r	r	9
Miller's Woodland	8.5	" 7	July 3.	6	m	r	r	8.5
Philadelphia	7	" 4	June 28.	6	l	r c	d r	9.5
Rancocas	7.5	" 6	" 29.	7	m	r	r	8.5
Red Cluster	8.5	" 8	July 1.	8.5	m	r c	r	9
Royal Church	8.5	" 5	" 3.	7	l	r c	d c	8.5
Scarlet Gem	8	" 8	June 28.	6	m	r	b r	9
Talcott	8.5	" 6	" 26.	5	m	r	d r	8
Thompson Early	8	" 6	" 28.	6	m	r	d r	9
Turner	8.5	" 4	" 30.	7	l	o	r	9

NOTES ON VARIETIES.

Cuthbert.—The plant is vigorous and healthy. This variety has yet no superior for general planting. It is valuable either for home use or for market.

Gladstone.—This variety, in addition to a small crop in the usual season, furnished two pickings the middle of October. The variety has little to recommend it for general planting.

Golden Queen is clear, bright yellow in color and of high quality. It is a desirable variety for the home garden.

Hansell and *Michigan Early* are hardy in plant and as early ripening sorts may be planted to a limited extent.

Royal Church.—The berries have the fault of falling to pieces very easily. The bush is hardy, of vigorous growth and fairly productive.

Turner is valuable for the extreme hardiness of the plant and the mild flavor of the fruit.

AGRICULTURAL COLLEGE, MICH.,
April 1, 1895.

NATIVE PLUMS.

U. P. HEDRICK.

Native plums have ıeceived but little attention in Michigan. In fact, until the exhaustive study of them, made by Prof. Bailey of Cornell a few years ago, but little had been done elsewhere and the literature upon the subject was scant and fragmentary. Within the last few years, however, they have been coming somewhat into prominence, but there is still a great difference of opinion among fruit growers as to their merit. In a small way they are successfully grown in various parts of the State, and the indications are that large plantations of the better kinds could be made profitable in some localities and under certain conditions. At any rate they deserve to be better known by Michigan fruit growers.

The market demand for them is still somewhat limited, but is steadily increasing for the better kinds, and the careful grower who has access to the large markets, or who controls a small select trade will find no trouble in disposing of his crop. Good fruits of the American plums come into the markets at least three weeks before the European varieties are marketable. They command prices, when choice and in small packages, ranging from $2 to $4 per bushel. While the demand for the earliest varieties is greater, yet the later ones have qualities which commend them as well worth attention.

The native plums have many qualities which make them desirable for the general farmer or for home use. The trees of most of the varieties are hardy, vigorous and very productive. The fruit comes early, keeps well, and has a fine appearance, and, though poorer in quality and inferior in size, is very acceptable as offering a greater variety of fruits. A strong point with those who grow them in a small way is their comparative immunity from insects and fungous diseases.

NATIVE PLUMS AT THE EXPERIMENT STATION.

It is doubtful if a much more comprehensive orchard of native plums can be found than this Station's plantation. It consists of 80 trees, embracing 35 of the better varieties planted in the spring of 1886, the trees having been obtained of D. B. Wier of Lacon, Ill., and T. V. Munson of Dennison, Texas. The soil of the orchard is a well drained clay loam, having a stiff subsoil composed of gravel and clay. The trees were planted 18 feet apart each way. Crops of vegetables have been grown in the

orchard every season so that the ground has received good cultivation. The manuring has consisted of an occasional application of composted barnyard manure. This treatment has produced a healthy, vigorous, growth of trees and productiveness in fruit. The trees, which have been remarkably free from diseases, bore their first fruit in 1890, and the increase in quantity has been rapid, nearly all the trees bearing a large crop last season.

PROPAGATION AND CULTIVATION.

In propagation, the common stocks, Marianna and myrobalan are largely used. The various varieties work well upon *Prunus Americana* and other native species, though the Chickasaws are said to be undesirable because of their habit of sprouting and sending out suckers. *Prunus Americana* stocks are especially suitable for northern climates, because of their hardiness. In the south the peach is largely used.

Methods of planting and cultivation need not vary from those employed with the common plums, except that, as many of the varieties of native plums are not fertile, owing to the impotency of the pollen upon flowers of the same variety, the prospective grower must bear in mind that, with native plums in particular, he must practice mixed planting in order to secure their fertilization. Some of the best kinds, including Wild Goose and Miner, are worthless unless so planted. It is a matter of some difficulty and considerable importance, to determine what varieties should be planted near each other, in order to have the best mutual effect as pollenizers. No definite rules for planting can be given without further experimentation, and about all that can be said is that trees of different varieties blooming at the same time should be planted near each other. They can be so planted that a tree of a very polleniferous variety will fertilize several barren trees. Some growers maintain that the mutual fertilizing trees should be planted very close, eight or ten feet apart, but experience here does not lead us to think close planting is at all necessary. Prof. Bailey says that it is a "common opinion among plum growers that the European plums, peaches and even the cherry will fertilize the Wild Goose plum" and a case cited seemed to lend color to the view, but the writer knows of three Wild Goose plum trees that stood in the midst of an orchard of several varities of common plums and a row of cherry trees bordered the plum orchard, but not a plum did the Wild Goose trees bear, and the trees were finally cut down by the owner. This shows at least that considerable care must be observed in planting trees to fertilize those that are not self-fertile.

SOILS AND LOCATIONS FOR NATIVE PLUMS.

Michigan has considerable territory that is admirably adapted for growing these plums. Undoubtedly the country adjoining the great lakes, especially that northward, is capable of greatest development for this industry, as it is favored by soil, climate and immunity from insects aud diseases. As a class, the native plums are not particular and will thrive on various soils, although extremes in sand, clay or muck must be avoided. In an ideal soil, the trees should make a hard, strong growth, the wood should mature early and well, the trees should bear young, and the fruit should be well flavored and highly colored.

The climate of Michigan is suitable for growing most of the native plums, in any part of the State except, perhaps, in the central and northern portions of the upper peninsula. In the north, especially where it is at all frosty it is well not to plant trees on a southern exposure where the buds may start and be nipped by a late frost.

It is easy to produce an overgrowth in the native plums; if they run too much to heavy tops and foliage they are not so productive of fruit, the wind easily breaks them down and they do not bear so early. Such overgrowths are caused by a soil too strong or by the use of nitrogenous manures in large quantities.

CHARACTERISTICS OF NATIVE PLUMS.

There are over 150 named varieties of native plums scattered throughout the country; experimenters are annually introducing seedlings and since any very promising wild plum tree may be the beginning of a new variety there is still abundant material to draw from. There are several groups of the plums, the distinctive lines of which have been drawn with considerable accuracy. But the rapid multiplication of varieties from seed, many the product of natural crosses, has made intermediate forms so numerous, and complicated the classification so much, that it is a difficult matter to assign varieties to their true positions. Because of this, and since a scientific classification is not strictly necessary for commercial purposes, a brief description of the varieties must take the place of a detailed classification.

It is not easy to give even the general characteristics of the native plums. There are, even in varieties of the same group, manifold variations in the character of the trees, flowers and fruits. Following the classification given in Bulletin 103, there are five groups of interest to Michigan growers.

Clinton.—Fruit medium to large, round, oblong or elliptical; skin thick, mottled with dark red; flesh firm, flavor sweet and pleasant; stone clinging, circular, smooth; leaves large, serrate, pointed, with glandular stalks; trees vigorous and very prolific; season early to medium, from August 1 to 15.

De Soto.—Fruit large, round, somewhat oblong; skin thick, dark red and with a heavy bloom; stone large, roughish, rather broad; stem $\frac{3}{4}$ inch long, slender; cavity broad and shallow; suture a line; flesh firm, flavor sweet and good; leaves oblong oval, medium size, acute, serrate, stalks glandular; season early, last of July and first of August. One of the best of the American plums.

Forest Rose.—Fruit large, round, a little oblong, and sometimes pointed; skin thin, red or purple; flesh firm, quality good; stone clinging, broad, smooth, flat; leaves obovate, pointed, finely serrate, stalks glandular; trees with spreading, open heads and thorny branches; not prolific on the Station grounds; season medium, August.

Garfield.—Fruit small to medium, oblong oval; skin rather thick, very dark red; cavity small and shallow; fruit stems long and slender; suture a dark red line; flesh firm, juicy, yellowish, flavor acid, pleasant; leaves large, ovate-lanceolate, finely serrate, stalk glandular; trees weak in growth and unproductive; season very late, September and October.

Itaska.—Fruit small, oblong oval; skin dark red, thick and tough; flesh firm, stringy, quality poor; leaves large and thick with glandular stalks; trees dwarf in habit with massed foliage of a peculiar pinkish tint; characteristics of the tree very prominent; season medium to late; of little if any value.

Maquoketa.—Fruit medium size, round, oblong; skin tough, dark red, purple bloom; stone clinging, short, pointed, rough; leaves large, smooth, dark green, stalks glandless; stem short, stout, in a very shallow cavity; suture prominent dividing the plum into halves; season late, the fruit colors early but is a long while in maturing. A poor variety.

Marianna.—Fruit small to medium, round; skin thin, bright red speckled with white; flesh soft, juicy, flavor mildly acid, insipid, poor; stone clinging, rough; trees much branched with long slender twigs; leaves oblong lanceolate, small, finely serrate, dark green; season early, last of July and first of August. Of little value.

Miner.—Fruit large, round, oblong; dark red skin, mottled, thick and tough; flesh firm, sweet, quality good; stone clinging, round smooth; leaves large, serrate, stalks glandless; trees vigorous and prolific; season medium. An old and popular variety. Miner and Clinton are almost idenical, differing only in foliage.

Moreman.— Fruit small, round; skin thick, dark cherry red with a yellowish tinge opposite the sun; flesh firm with a pleasant acid flavor; stone small, circular, a little pointed; leaves rather large, ovate with a long point, serrate, dull green, stalks glandless; trees thrifty, vigorous, and quite free from fungous diseases; season late, fruits not ripening at the same time.

Newman.—Fruit medium to large, round, somewhat oblong, inclined to be irregular; skin thin, light bright red, without bloom, dotted with spots near the apex, and with a yellow cheek opposite the sun; stem short and slender, cavity small; suture a bright red line; flesh firm, juicy, fibrous, adhering to a small, flat, rough, stone; flavor acid, pleasant; trees thrifty, large, round topped, foliage good; leaves large, oblong-ovate, acuminate, finely serrate; season medium. The best variety of the Chickasaw plums.

Pottawattamie.—Fruit medium to large; skin thin, bright red with yellow streaks running partly around the fruit; stem long and slender; flesh firm, juicy, quality fair; cavity small, suture a red line; leaves conduplicate or trough-like, oblong lanceolate, small; stone, large, broad, rough; growth slender, spreading, zigzag; tree very vigorous, prolific; season early, August.

Purple Yosemite.—Fruit medium to large, round; skin thick, bitter, tough, dark red or purple, covered with bloom; flesh firm, yellowish, stringy; flavor acid, good; stone large, flat, smooth, inclined to be free; leaves large, ovate, smooth, dull in color; growth upright, strong, spreading into stiff branches; trees productive; season, August.

Rollingstone.—Fruit large, round, somewhat flattened at the ends; skin tough, pinkish purple, mottled; flesh firm, sweet, good; stone clinging, circular, flat, smooth; leaves large, serrate, smooth, stalk slender, glandular; cavity broad, shallow, suture a line; trees very vigorous and prolific; season early or medium, being about that of De Soto.

Robinson.—Fruit medium size, round, oblong; skin thin, dull red with yellow blotches opposite the sun; flesh firm, juicy, reddish, quality good; stem short, slender, set in an abrupt narrow cavity; leaves small, oblong lanceolate, stalk short; trees spreading, not branching so much and shoots not so zigzag as in the typical Chickasaw, very prolific; season, August and early September.

Yellow Yosemite.—Only a shade of difference between this and Purple Yosemite; the color being some lighter than that plum with a quite decided yellow tinge; tree and foliage differ but little, season about the same, perhaps a few days later.

Weaver—Fruit large, oblong-oval; skin thin, yellow, mottled with red; flesh firm, flavor excellent, sweet; stone large, flat, smooth, pointed, cling; leaves large, toothed, pubescent underneath; stalk short, glandless; cavity large, suture distinct; season late, end of September. The most popular of the late kinds.

Wild Goose.—Fruit large, oblong-oval, apex pointed; skin thin, bright red; flesh not very firm, a little stringy, quality fair; stone clinging, long, pointed; leaves oblong-lanceolate, closely serrate, acuminate, stalks with several glands; shoots smooth, slender, spreading; trees very thrifty and productive; season early, August. Because of earliness, productiveness, and handsome appearance of fruit, one of the best of the native plums.

SUMMARY.

1. Within the last few years native plums have been coming somewhat into prominence. The opinions of fruit growers differ as to their merit.

2. The market demand for them is limited, although it is steadily increasing for the early kinds. They come into market about three weeks before the European varieties.

3. The station has tested 35 of the better varieties which were planted in the spring of 1886, the trees being obtained from D. B. Weir, Lacon, Ill., and T. V. Munson, Dennison, Texas.

4. In propagating native plums, *Marianna* and *myrobolon* stocks are largely used. *Prunus Americana* is well adapted as a stock for northern climates.

5. Methods of planting and cultivation do not differ from those used with common plums except that mixed planting must be followed in order to secure the fertilization of many of the native plums.

6. Native plums are not particular as to soil, although extremes in sand, clay and muck should be avoided. A soil too strong or too rich in nitrogenous matter causes a heavy growth of foliage at the expense of productiveness.

7. There are about 150 varieties of native plums embraced in five species, of which the most important are, *Prunus Americana P. hortulana* and *P. angustifolia.*

8. The most valuable of the native plums are De Soto, Rollingstone, Weaver, Wild Goose, Miner and Newman, of which Wild Goose, De Soto and Miner are probably the most popular.

9. In general the native plums are to be recommended to those who want plums for an early market; because of their immunity from diseases and insects, to the general farmer; and to large growers who wants a greater variety of fruits.

RUSSIAN CHERRIES.

U. P. HEDRICK.

For a number of years considerable interest has been shown in Russian fruits. Several importations have been made and some of the kinds are promising for the colder portions of our country. A few varieties promise well for milder regions, and bid fair to furnish our general horticulture with fruits of value.

The introduction of Russian cherries into the United States, dates from 1882, when Prof. Budd of Iowa and Mr. Charles Gibb, a Canadian horticulturist, visited Europe and made selections of what they considered the best varieties growing in the colder portions. The trees were taken to Iowa and Canada, where the hardiest of the common cherries fail utterly, and in both places proved hardy. Prof. Budd's trees in Iowa were one year old when imported, and were set in an orchard where the dry summers and cold winters had killed all the common cherries, including the hardy Early Richmond and English Marello.

With this treatment the Russian cherries grew and thrived, notwithstanding the fact, too, that they were severely cut for cions and buds.

The trees were soon well distributed among the Experiment Stations, and several reports have been made concerning their peculiarities and values, with varying opinions as to their general worth. Through the stations and the usual channels of trade they have now been quite generally distributed to the public, and some of them are highly spoken of by practical growers, who say that they have many points of usefulness for the general fruit grower. In our State, with a few exceptions, they will not be in great demand except in the Upper Peninsula, and in the northern inland portions of the Lower Peninsula, where the common cherries fail to grow. For these regions, as a good substitute for the other cherries, they are recommended. They are also commended to those who live in localities where late frosts make the cherry crop uncertain.

The general grower who desires a larger variety of fruit will find among the Russian cherries, varieties, which approach the common cherries in size, appearance and quality, they come very late in the season and this may be a point in their favor with some growers.

It is the object of this bulletin to give information regarding the hardier and more promising sorts that have been tested on the Station grounds and which will be desirable for growing in sections where the common kinds fail.

The history of Russian cherries on the Station grounds is as follows: In the spring of 1888, thirty trees, embracing twelve varieties, were obtained from Prof. Budd, of Iowa. The soil of the cherry orchard is the same as that upon which the American plums were grown, and the trees

have received the same care and cultivation. The trees are vigorous, strong and healthy; they first bore fruit in 1891, since which most of the trees have borne every year.

CHARACTERISTICS OF RUSSIAN CHERRIES.

There are now scattered through the country almost half a hundred named varieties of Russian cherries. There are several groups of them, but the distinctive lines, are not as yet, well drawn and as the intermediate forms are numerous, a proper classification would be difficult and will not be attempted. The aim will be to give only a few general characteristics of the cherries and as accurate a description of the varieties as is possible.

The nomenclature of the Russian cherries is badly confused. In Russia different names are given to the same fruit in different localities, while the same name may be given to different fruits growing in adjacent districts. The names, though very formidable to an English speaking person, are quite simple and without any individuality, mostly expressing some quality of the fruit, such as sweet, transparent, white, round, etc., and it is not easy to convert them into good English names. Then again seedlings of like parentage resemble each other so much that it is difficult to distinguish between varieties. However, most of the names used in this bulletin have now become pretty well fixed.

The most distinct characteristics of the Russian cherries are, their dwarf, compact habit of growth; their small and narrow leaves which are thick, but finely textured; and, in general, a deep purplish-red or reddish-black, fruit of a peculiar bitter and often very pleasant flavor. As grown by the peasants in Russia the trees are generally of bush form, as they receive but little care, seldom any cultivation, and are often grown in dense thickets. Sometimes they are planted under other trees as our currants are. They are usually grown from seed and in sod, though seedlings vary much from the parent, so that the best trees are grown from sprouts. Grafting is rarely practiced. Some of the trees are erect in growth though the weeping form is usually considered better. With such careless cultivation, it can easily be seen, that if profitable in Russia, with the comparatively careful cultivation which we would give them, they ought to prove profitable for us. In the main the trees have the same characteristics here as in Russia, except that the bush form is never grown. The trees are dwarf, compact, and vigorous in growth. Leaves and flowers appear later, and the fruit ripens later than with the common cherries. The fruit is borne in small bunches and tends to remain for a long while on the trees, even after ripening.

The following are the more promising kinds that have tested on the Station grounds:

Bessarabian.—Fruit rather large, roundish, heart-shaped, irregular; borne in pairs, stalks long, slender; cavity deep, suture distinct; when fully ripe, dark red in color; flavor acid, slightly astringent; pit medium size, round; trees dwarf, shaped like May Duke; foliage good, leaves small, coarsely serrate. One of the hardiest and most prolific of the Russian cherries.

Griotte du Nord.—Fruit medium size, round, slightly heart-shaped; borne in pairs, stalk long, slender; dark red in color; flesh firm, reddish, flavor quite acid, slightly bitter; pit small, round; tree very hardy and vigorous, quite dwarf and compact in habit and a slow grower. It is much like Bessarabian, differing mostly in habit of tree and flavor of fruit. Season, midsummer.

George Glass.—A variety similar to, and identical with Bessarabian. Introduced from eastern Europe to Iowa by immigrants; it was discovered in Marshall county.

Lithaur Weichsel.—Fruit small and rather poor, round; suture distinct, cavity deep; stalk long and slender; skin thick, dark purple almost black; flesh firm, reddish, juice colored; flavor acid and bitter, quality poor; pit very small; tree strong and vigorous. Used only for culinary purposes; season last of July.

Sklanka.—Fruit large and handsome, color yellow with red cheek; flesh firm, yellowish; flavor sub-acid, good; pit small and somewhat flat; tree well formed, round topped, branches drooping, foliage good; a handsome tree producing an abundance of excellent fruit.

Brusseler Braune.—Fruit large, globular, slightly heart-shaped, a little inclined to be irregular and to vary in size; in color very dark red; flesh firm, reddish, acid and slightly bitter; stalk long, cavity deep; pits large and flat; tree very vigorous and prolific, shoots ascending, foliage good; season middle of July. One of the best of the Russian cherries.

Ostheim.—Fruit about the size of the Richmond; heart-shaped; dark red, or brownish black, when ripe; skin thick; cavity deep, stalk long, suture obscure; flesh firm, but tender, juicy; flavor mildly acid, very good; pit large, somewhat flattened; trees vigorous, and hardy, round topped, resembling the Morello type; season 20th July to the end of July. One of the best known of this class of cherries.

Schatten Amarelle.—This cherry is almost identical with Brusseler Braune. It is, perhaps, a little smaller, not quite so globular, and not so dark in color, and is a few days earlier. But in flavor, appearance of tree and foliage they are alike in every respect. Like the Brusseler Braune it promises to be one of the best of this class of cherries.

Lutovka.—In appearance the fruit of the Lutovka resembles the Sklanka very much. The quality, however, is better, as it lacks the astringency of the Sklanka; the season is later. The trees of the two varieties resemble each other in shape, but Lutovka is a stronger grower, with coarser shoots and foliage.

SUMMARY.

1. The introduction of Russian cherries in the United States dates from 1882, when Prof. Budd, of Iowa, and Charles Gibb, of Canada, imported a number of varieties from Russia.

2. Russian cherries are recommended for those localities in Michigan which are too cold for the common cherries. They are for these regions a good substitute for common cherries. Since they ripen very late, they may, for this reason, find favor with the general grower.

3. The chief characteristics of the Russian cherries are: A dwarf, compact habit of growth; small narrow leaves, which are thick and finely textured; and a deep purplish-red, or reddish-black fruit; and a peculiar astringent flavor which is often very pleasant; leaves and flowers appear later and the fruit ripens later than those of the common cherries.

4. The following varieties do best on the Station grounds: Bessarabian, very hardy and prolific; Brusseler Braune, fruit large, tree vigorous and prolific; Ostheim, one of the best known of the Russian cherries.

AGRICULTURAL COLLEGE, MICH.,
April 1, 1895.

THE APPLE ORCHARD.

BY L. R. TAFT.

A few years ago the apple crop in Michigan was of large commercial importance and the fame of Michigan apples reached all parts of the country. For a number of years the crop has been small and in some seasons has not been sufficient to supply the local demand. While other causes may have contributed to the loss of the crop, neglect, or at least lack of proper care, can be charged in many cases with being the principal reason for the loss. Letters are frequently received inquiring as to the best methods of planting and caring for an orchard, the soil and fertilizers needed and the remedies for the insects and diseases to whose attack the apple is subject, and to supply an evident desire for information on the subject, this bulletin has been prepared.

HISTORY OF THE APPLE.

Although there is no direct evidence as to the origin of our cultivated varieties of apples, they are supposed to have been derived from the wild crab, which is common in all parts of temperate Europe. Improved varieties of this fruit were certainly in cultivation long before the Christian era, as Pliny and other writers of his time speak of the apple as one of the fruits of the Romans, who were said to have brought it from Armenia. Even in those times varieties were plentiful, as Pliny enumerates twenty-two, including sweet, dessert and cooking sorts, and one kind that was seedless.

The apple was carried to all parts of the empire where Roman garrisons were established, and thus undoubtedly reached England. When this country was settled, seeds, cions and trees were brought over, and from the orchards then or soon after planted, many of the varieties of today have been derived. While a few varieties now in cultivation have been brought directly from Europe, most of the kinds commonly grown are of American origin and have come as chance seedlings from older sorts. In many cases it is probable that they are the result of natural crosses but in a few cases artificial crossing has been practiced.

As a rule when apple seeds are planted, many of the trees obtained will be thorny, and will give strong evidence of their origin. Most of them will produce small fruits that will be inferior to that borne by the original

variety, but occasionally one will be obtained that makes a strong growth, has large healthy foliage, and produces an abundant crop of large fruit that is of excellent quality. Out of thousands of seedlings it is seldom that a sort is obtained that is better than the older varieties.

Much better results can be expected if cross-fertilization is resorted to. This is brought about by selecting two varieties that have the qualities desired, and conveying the pollen from the anthers of one to the pistil of the other. To insure that no other pollen gains entrance to the pistils the flowers in which they are should have the anthers removed before the petals open and should then be covered with small paper sacks, until several days after the crossing is done, to prevent the pollen from other flowers reaching the pistil.

THE FAILURE OF THE APPLE CROP.

Barrenness in an orchard is in many cases due to the natural tendency of the variety, as some varieties are very shy bearers, while the Northern Spy among others is often condemned for barrenness from the fact that the trees are late in coming into bearing.

In the eastern states, the apple has, "odd and even" bearing years. This is due to the fact that upon the bearing years all of the energies of the trees are exerted in developing the crop of fruit, so that no buds are formed on the fruit spurs for the next year's crop, and as a result the following will be an "odd year." This is quite generally the case in old neglected orchards, that are poorly supplied with plant food. The bearing year can be changed if in any way the tree is prevented from developing a crop of fruit, as can be done by destroying the blossoms or small fruits, since the trees will then be able to develop buds for the next year's crop.

Aside from the above, the partial failure of the apple crop in Michigan for the past few years, may undoubtedly be ascribed to a variety of causes. A very large proportion of the orchards in the southern part of the State are now quite old and have been growing for years in sod. Many of them have in the past borne several large crops of fruit, which has drawn heavily on the soil, while in very few cases have steps been taken to return to the soil the plant food taken out by the trees. Added to these reasons we have the total absence of care in many cases, besides the injury that must result from improper pruning and unfavorable location. As if this were not enough to insure failure, various climatic conditions have combined to bring about the same results, and their effect in some years has been so great that the crops have been lost even when other conditions were favorable and the trees were well cared for.

When we have an even climate, the trees can withstand very low temperatures, but if the trees are poorly ripened in the autumn, or if the weather of January or February is such that the sap starts and the buds swell, great harm may be done by zero weather.

In some seasons we have had cold rains lasting a number of days just as the foliage and buds were appearing. As a result the pollen is washed from the anthers, so that the trees are not only prevented from fruiting, but the cold weather may give them a serious check from which they will be a long time in recovering.

The above conditions are particularly favorable for the development of fungi, and to the apple scab fungus we may attribute much of the failure of our orchards to bear, as, while other conditions were favorable, the crop

has been lost. The tender flowers are attacked on the ovary or pedicel and almost invariably they drop from the fruit spurs.

In the weak condition of the trees, the foliage is often severely injured; if any of the fruits set, they are likely to be attacked and, unless fungicides are applied, will be small and misshapen.

Some have ascribed the failure of the apple crop to the changes in climate due to the cutting off of the forests, and from the above it may be seen that indirectly this may have had much to do with the loss.

NOTES ON APPLE CULTURE.

The question of apple growing interests nearly every farmer, as it is a crop that is easily grown, succeeding in most localities and furnishing at a small expense in time, a large amount of nourishing and healthy food for the family.

While it is desirable that every person who is the owner of even a village lot should have trees enough to supply fruit for his own use, it is not wise to undertake the growing of this or any other fruit for market, unless it is quite certain that the natural conditions are favorable, and one is well posted as to the best methods of handling the orchard.

Success in apple culture for commercial purposes can only be secured when one chooses a suitable location and soil, selects good varieties and good trees, properly plants and cares for them, supplies the needed plant food, fights the insects and fungi and harvests and places his crop on the market in good condition, and it should not be expected unless the above conditions are complied with.

Letters of inquiry upon one or all of the above points are frequently received, and, as they indicate a wide-spread desire for information, the following notes have been prepared. They contain not only the results of our own experience, but the methods recommended are those practiced by our most successful orchardists.

ADAPTATION OF MICHIGAN TO APPLE CULTURE.

Michigan has for many years held a high place as an apple growing state, as her success at various national and state fairs, when her apples came into competition with those from other states, abundantly testifies. The fruit is large in size, of high color, rich flavor and has good keeping and shipping qualities. For a number of years, for reasons mentioned above, the crop has been but a partial one.

While suitable locations for an apple orchard cannot be found on every farm, there are few townships in the counties south of Gladwin, where apples cannot be grown successfully. In the northern and central counties in the lower peninsula, while the soil is generally rather light, there are some orchards that are in a fairly flourishing condition. Many orchards in the upper peninsula also seem to be doing well.

For the past four or five years, the better part of the apple crop has come from the counties north of Muskegon, taking about two tiers from the shore of Lake Michigan. Among the reasons for this it may be mentioned that the soil is new and has not been robbed of its plant food by grain and other crops. The trees are generally young and vigorous and are seldom started by warm weather in winter. Growth begins in the

spring about ten days later than in Southern Michigan and the blossoms are less likely to be injured by the spring frosts, while the cold rains that have for several years nearly destroyed the crop in the southern counties by washing the pollen from the flowers and offering favorable conditions for the development of fungi, have come before the flowers have opened on the trees in the northern counties.

The insects are less plentiful in that section and a crop can be expected with considerable certainty on account of the easy transition from autumn to winter and from winter to spring.

SOIL AND LOCATION.

For a commercial orchard it is of the utmost importance that the soil and location should be well adapted to the growth of the trees. It can be put down at the outset that apples will not thrive in a soil that is very dry and sandy, or very heavy and wet. It is often said that apples will do well on any high, strong, well-drained soil, that will grow good wheat or corn, and this will generally be found to be true.

While it will always be well to avoid either extreme, a moderately heavy sandy loam or a light clay loam will generally prove satisfactory if suitably located.

The orchard should be considerably elevated above the land surrounding it, not only because that may aid in securing good soil drainage, but, of even more importance, because of its aid in giving proper air drainage, as the cold air will flow down to the lower levels and thus lessen the danger from extreme cold in winter and from spring frosts. Another advantage not generally understood is that the scab and other fungi are more troublesome in hollows than upon hillsides.

DRAINAGE.

Few plants will make a satisfactory growth, if at any time during the growing season their roots are in standing water and the apple is no exception. While it is better to have the soil naturally drained, tile underdrainage should be supplied in case the water does not drain off quickly after a rain. If lines of two and one-half or three inch drain tile are laid at a depth of three and one-half or four feet, midway between the rows of trees, they will quickly rid the land of surplus water.

The objection is often made that they will fill up, but this seldom happens except to such lines as carry the water from a spring. In that case there will generally be water in the tiles while the soil around may be dry, and the roots will be very likely, under those conditions, to enter at the joints of the tiles and fill them so completely as to stop the flow of the water. When, however, the only duty of the tiles is to carry off the surplus water in the soil, the roots will seldom enter, as there will be all the moisture they care for in the soil so long as there is water in the tiles. With our common fruits, there will seldom be an exception to this rule, but the willow and elm sometimes completely fill tiles even when the soil is very wet.

It does not follow that a stiff, heavy soil, even though it be high and rolling, can be brought into good condition for an apple orchard, even though it be thoroughly tile drained, as at best it will be stiff and lumpy. The expense will be considerable, and the result will be less satisfactory

than when the trees are set upon land that is naturally drained. While it will be advisable and even necessary to drain such land, in case circumstances make it desirable that it be used for an apple orchard, it will generally be preferable if one is to plant a commercial orchard to choose a location that has good natural drainage.

PREPARATION OF THE LAND.

At the time of planting the land should be in good tilth, and well supplied with plant food. As a rule, in case the land needs to be artificially fertilized, it is preferable to apply the manure to a previous crop, such as corn or potatoes, or if there is no particular hurry, if the land can be seeded to clover and the sod turned under, it will be in the best possible condition for planting.

The plowing should be deep, and if there is a stiff subsoil near the surface, it will pay to use a subsoil plow along the lines of the rows, although as noted above it is not advisable to use this kind of a soil for a commercial apple orchard. Having brought the land into a good condition for planting, it is ready for the trees.

SELECTION OF TREES.

The success or failure of the orchard will depend largely upon the varieties and the character of the trees purchased.

While many experienced orchardists wisely prefer a strong one-year tree, to anything that is older, as it enables them to form the head at the height and the manner they prefer, for the ordinary planter a somewhat larger size is to be commended. As a rule the two-year, medium, four to five feet, five-eighths to three-quarter inch trees will do as well, or better, than those of a larger size, and the cost and expense for boxing, freight and planting will be materially less than for the three or four-year old trees that some planters insist upon having. The No. 1, two-year trees, graded as five to seven feet, three-quarter inch and upward, are as a rule not objectionably large.

While it is desirable to obtain trees at a reasonable price, cheapness should not be the only consideration. When buying trees of the above-mentioned sizes, care should be taken that the nurseryman does not work off cull trees that are three or four years old. By supplying such trees and, even worse, if he is unscrupulous, substituting worthless varieties, a nurseryman or tree dealer is often able to make a low price that will tempt the purchaser, who in the end will find that the trees would have been dear as a gift. The fact that a healthy tree of a good variety may in good seasons return a crop worth from ten to twenty or more dollars, while the crop from a poor tree, even if it lives to come to maturity, may not be worth gathering, should show every one that too great care cannot be taken in selecting the varieties and trees, when planting an orchard.

In the present days of low prices, trees for an orchard can be obtained for a comparatively small sum. If only a few trees are needed, it may be well to secure them from a local agent, whose stock came from a responsible nursery, as the cost for packing and express upon a small bundle might be more than his commission, but if from one hundred to five hundred trees are needed, it will be better to get them directly from a nursery.

As a rule, the trees should be brought from the nearest reliable nursery, when good trees of the kinds wanted can be obtained at a reasonable price. If they have to be shipped in the cars, however, it will make but little difference whether they are sent 50 or 150 miles, so far as the distance is concerned. In selecting a nursery, however, it is well to choose one with the soil and climate as much like those where the orchard is located as is possible, but from the fact that some sections do not have nurseries or they are not reliable, it often becomes necessary to go some distance for the trees. If the trees needed cannot be found in some local nursery, it will be well to send a list of the numbers and varieties required to several reliable firms, and obtain estimates as to the cost.

For not less than five hundred trees of standard varieties, medium size two-year, the cost should not be more than six or seven cents each, and the first-class trees should not be more than eight cents. When smaller numbers are wanted, the price will range from eight to fifteen cents, according to size of trees and number wanted.

These prices are the highest that should be paid, as many reliable nurseries quote prices by the thousand considerably less than those given. It must not be forgotten, however, that these prices are for trees at the nursery, and that there will be an additional charge of nearly one cent per tree for small lots, for boxing and packing, and perhaps as much more for freight.

SEASON FOR PLANTING.

At whatever time trees are planted, it will be found well to give the order early in the fall, as there will be less chance of receiving trees that have been culled over, and the best trees and best varieties picked out. If a large purchase is to be made it will be well to select the trees early in the autumn, and arrange that they shall not be *stripped* until the leaves begin to fall. It is the custom in large nurseries to strip the leaves from the trees before digging. This is the proper thing to do if the time for it has come, which is generally by the middle of October, but in order to get the work done, the stripping is often performed before the wood is properly ripened. The soft, green, watery shoots are unable to withstand the winter and the trees may be severely injured, especially if the winter is a severe one.

In case the land is thoroughly drained, and yet reasonably moist from the autumn rains, fall planting is upon many accounts preferable, as the trees will become established, while the roots will have callused and will be ready to throw out new fibres by the time growth starts in the spring.

One great trouble with spring planting is that the warm weather often comes on so quickly after the frost is out of the ground, that the planting may not be completed until the buds have started, and at the best this is likely to give them a check. If planting is delayed until spring, the trees should be heeled in. For this purpose a trench should be dug in some well-drained place, one foot deep and three feet wide, generally running north and south, in which the trees should be placed. They are preferably set leaning to the south, and should not be so thick that the roots will be in contact. The soil should be pressed firmly about them and for tender trees the lower half of the trunks should be covered. Straw and rubbish of all kinds should not be left near them, as it will invite the field mice which may girdle and spoil the trees.

DISTANCE FOR PLANTING.

The majority of planters err on the side of planting at too small distances. Some advise planting closer upon strong land than upon that which is light, but while more space is desirable to furnish the necessary moisture on a light soil, on the other hand it may be urged that upon the heavier soil the trees will make a much larger growth and the branches will interlace unless they have a good distance.

Leaving the character of the soil out of the question, we may say that the strong-growing, long-lived sorts should have at least forty feet each way, while the small and comparatively short-lived kinds, such as the Wagener, may be as near as two rods without danger of crowding.

The usual method is to plant in squares (Fig. 1) but the arrangement either in rectangles (Fig. 2), or in triangles (Fig. 3) will often utilize the

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*   *          *  *  *  *          *   *   *   *
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*   *          *  *  *  *            *   *   *   *
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Fig. 1.—Squares. Fig. 2.—Rectangles. Fig. 3.—Triangles.

land to better advantage. When varieties like the Northern Spy, that are a long time coming into bearing are planted, it is a good plan to have each of these permanent trees in the center of a hexagon with six or of a square containing eight trees (Fig. 4, A and B) of some variety that

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  o   o   o   o             o   o   o   o   o

o   x   o   x   o           o   x   o   x   o

  o   o   o   o             o   o   o   o   o
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Fig. 4 A.—*x*, Northern Spy; *o*, Wagener. Fig. 4 B.

bears early, but is generally short-lived. In this way there will be one Spy to three of the others. The Northern Spy trees should then be 45 feet each way if in squares, or 40x45 if in hexagon. This plan can only recommend when the land is to have extra care and the surplus trees are taken out when the others need the room.

As a rule the planting of peaches or other fruits between the rows is not to be commended, unless more than usual care and fertilization are given, especially as there is danger of leaving the other fruits too long. Above all it is poor policy to grow strawberries or raspberries between the rows of trees after the latter come into bearing, or at any time in fact, as none of them will receive the amount of food or water required for a satisfactory growth.

THE PROPAGATION OF APPLE TREES.

The ordinary standard apple trees are propagated by budding or grafting the improved varieties upon seedling stocks. The seedlings are grown for one or two years in the seed bed, from seeds obtained from the cider

mill, by washing out the pomace, or from imported French crab seed, which is preferable, unless it is known that the seed is from strong growing hardy varieties.

If the trees are to be grown by budding, the seedlings are dug in the fall and heeled-in in the cellar or in some well drained place out of doors and there kept until spring. The soil for the apple nursery should be strong, moist and yet well drained. While the supply of plant food should be sufficient to promote a strong, straight, healthy growth, it should not be supplied with large amounts of undecomposed stable manure, as that would induce a watery growth that would not ripen.

As soon as the soil is dried off in the spring it should be deeply plowed and thoroughly fitted for the seedlings which, after the fibrous roots have been removed and the others cut back to a length of seven to nine inches, will be ready for planting.

They should be set, either with a spade or a dibble in straight rows from three feet eight inches to four feet apart, at intervals of from six to ten inches. The greater distances will give the best trees, but with strong soil and good care, a good grade of tree can be obtained if somewhat closer together. During the first season they will need to be frequently worked so that the ground will be kept loose and the moisture conserved. With good care they should be ready for budding by the last of July or the first of August. The cions are obtained from the growth of the present year and should have plump, firm, well-developed buds. The process of budding and the care of the young trees in the nursery is the same as given for the peach in Bulletin 103 and reprinted in the report of the State Board of Agriculture for 1894.

Propagation by Root-grafting.—The process of root-grafting differs from budding principally in that instead of a bud attached to a small piece of bark, several buds, attached to five or six inches of cion are so fastened to the stock that a union takes place and one part develops the root while the other produces the stems and leaves of the future tree.

Root-grafting is usually done by the nurseryman during the winter when the other work is less rushing. The usual method is by what is known as whip grafting, although other methods may be used.

Whole or Piece Roots.—The more common practice today is to cut up the roots of the seedlings into from two to four pieces from two to four inches long, and use these as roots for the cions. It is claimed by some that the proper way is to graft at the collar and thus get but one root from each seedling. It is urged in favor of the whole root graft that not only are better nursery trees produced, but that in the orchard the trees will get a better start and that the trees that have been collar-grafted will have a tendency to throw strong roots of the nature of tap roots deep down into the soil, while the short piece roots, and especially the second and third cuts will form but few roots and these will be mostly of a fibrous nature and develop in the surface soil. By rooting deeply the trees will be much less likely to be injured by a severe winter and will suffer less from drought. While much depends upon the soil in which the trees are grown and the nature of the variety, many of the claims made for the whole root certainly hold good. As compared with those grown from the first or upper cut there will be but little difference in the growth of the nursery trees and this will depend upon the length of the piece root. As a rule, however, the nursery tree grown from the whole root will

have rather more branching roots, but the difference will be so small that in the orchard it will not be noted after the first year. With most varieties the trees grown from the second, third and fourth cuts will be noticeably smaller and will have poorer roots. In the case of some of the stronger growing kinds like the Red Astrachan and Ben Davis, the trees will after the first year send out a number of roots from and above the graft which soon get ahead of those from the root, so that in their case the whole root has but little, if any, effect. Many western nurserymen prefer to use the short root, as they claim that when the whole root is used the trees make a late growth in the nursery and are often winter-killed. It is true that the stocks cost less when piece roots are used, and the trees can be more cheaply planted and dug, but as a rule more trees can be sold from an acre and they will often grade larger so that, after all, the cost of growing these trees will not be much more than when piece roots are used.

From our experiments it would seem best to use a generous length of root at any rate and in no case make more than two cuts.

The question is often asked as to the relative value of budded, whole root and piece root trees, and it may be stated that as a rule budded trees one year from bud are often as large and on some accounts are preferable to grafted trees that are two years from the graft. Whole root trees are also generally larger than piece root trees, but between budded and whole root grafted trees there is little difference, and they are as a rule to be preferred to those that are grown from piece roots.

Top-Worked Trees.—In case of some of the weak-growing sorts and those that are not entirely hardy when budded or root-grafted, it has been found that they will do much better when they are top-worked, or grafted at the height of four feet upon some strong, hardy stock. This may be done in the nursery but as a rule they cannot be purchased in this form and it becomes necessary either to purchase trees of the kind it is proposed to use as the stock and after growing them for a year, either in the garden or planted in the orchard, to whip-graft them with the desired sort.

Dwarf Apples.—While only desirable for growing as curiosities, or in case one has but a limited amount of ground, it may be well to explain just what is meant by dwarf apple trees. Any variety may be grown in this way, but they differ from standard trees of the same variety by being grafted upon some small growing species of apple, which tends to so check the growth that the size of the trees is much reduced. When very small trees are desired the stock selected is the Paradise apple and when worked upon this the trees are seldom more than four feet in height and bear at an early age; in case a somewhat larger apple is desired the Doucin apple is used as the stock.

VARIETIES OF APPLES TO PLANT.

So much depends upon the proper selection of varieties for planting, that it should have careful consideration. If one has a neighbor who is a successful grower of apples upon soil similar to that to be used for planting, it will be well to make a careful study of the varieties as they ripen and in this way one will be able to determine quite accurately the kinds it will be best to buy.

The character of the soil has so much to do that no one can recommend a list that will apply in all sections of a township even, but there are many well-known kinds that are generally grown with success and it will be better to plant them than to rely too much upon the advice of the average tree agent or the nursery catalogue.

A different selection should be made for home use from what would be planted for market, as in the former case it is desirable that the selection should be such as will give a succession throughout the season. There should be varieties adapted both for dessert and cooking purposes and sweet apples for the different seasons. While the hardiness and the productiveness of the varieties should be considered, care should be taken that the list contains dessert varieties of high quality for the different portions of the year.

As a list for family use the following would be desirable: Red Astrachan, Bough (Sweet), Oldenburgh, Primate, Chenango, Keswick, Maiden Blush, Shiawassee, Twenty Ounce, Bailey (Sweet), Westfield, Jonathan, Hubbardston, Grimes, Baldwin, Talman, King, R. I. Greening, Red Canada, Northern Spy and Golden Russet. While in some sections it might be well to leave out a part of these kinds and substitute others, the list will be found as a rule to answer as well any that can be made.

When designed for commercial purposes other things should be considered. Among the requirements for a commercial variety, in addition to the vigor and productiveness of the trees, may be mentioned the size and color of the fruit. They should be good keepers and should ship well. In securing these qualities the flavor of the fruit should not be lost sight of. While in the past the size and color have sufficed to sell fruit that was inferior in quality, the public are each year becoming more and more fastidious, particularly regarding their dessert fruit, so that although a fruit poor in quality may be sold to a man once, he is less likely to buy the same kind a second time. Moreover, the apples of high quality will sell for a higher price and more readily than others of the same size and color but of an inferior quality.

As a rule the list for commercial planting should be a short one and for the most part it should consist of winter varieties.

For local market a few summer sorts may be grown, and there are a few of the late autumn kinds that are worthy of growing upon a large scale, and among them are the King and Shiawassee, or Snow where the latter succeeds well.

The list given for a family orchard contains the cream of the varieties and almost any of the summer or autumn sorts may be grown with profit for sale upon a small scale, but to follow the King it would be well to select not over two or three of the following kinds: Northern Spy, Baldwin, Red Canada, Hubbardston, Jonathan, Wagener and Westfield. The Northern Spy is as reliable as any of them, but the trees are a long time in coming into bearing; Wagener and Jonathan are particularly valuable in some sections but they require extra care, as otherwise the trees are likely to produce small, inferior fruit from their tendency to overbear. The Baldwin in high, well drained locations is generally successful but is often injured by severe winters upon low land. The Red Canada is a poor orchard tree when root-grafted, but grafted standard high upon a strong stock it is very popular in many sections of the state.

DESCRIPTION OF VARIETIES.

Red Astrachan.—One of the most valuable and best known of the Russian apples. It is said to have been imported into England from Sweden about 1816. The tree is vigorous, hardy, and a regular and abundant bearer. Shoots spreading and ascending, stout and brown. Foliage thick, large and healthy. Fruit medium to large, roundish-oblate or slightly conical, regular. Skin greenish yellow, nearly covered with crimson, mottled and striped. Stalk one-half to three-fourths of an inch long, inserted in a regular cavity of medium depth; basin medium, nearly regular; calyx nearly closed. Flesh white, crisp and juicy, rather acid. One of the best culinary apples of its season, which is early August.

Bough (Sweet).—One of the best early sweet apples, highly valued for eating. Tree vigorous, round-headed and quite productive. Fruit conical-ovate, regular, greenish yellow with a few small brown dots. Stem rather long, in a deep, acute cavity, which is sometimes russeted; basin of moderate depth, narrow; calyx small, closed. Flesh white, tender and juicy, with a very sweet, sprightly flavor. Season, August.

Oldenburgh.—This is a Russian variety that is highly esteemed on account of its hardiness and productiveness. The tree is of only medium size, round-headed and an early bearer. Fruit of medium size, regular, flattened. Skin a waxy yellow nearly covered with stripes and splashes of red and carmine, with a light bloom. Cavity regular, acute; basin shallow, rather wide, generally irregular; calyx large and closed. Flesh yellowish-white, tender, juicy, and sub-acid. An excellent culinary sort and fair for eating.

Primate.—Tree vigorous, strong and stocky, shoots short and stout; buds quite prominent; fruit of medium size, roundish and slightly conical, angular and irregular, yellowish green; when ripe nearly white with a slight blush; cavity narrow, pointed, irregular; stem medium to long; basin abrupt and irregular; eye long, but small and closed; flesh white, tender and juicy, with a mild sub-acid flavor. Quality very good. One of the best family apples, lasting from August to October.

Chenango.—Tree a vigorous grower, spreading, but with an upright tendency; fruit medium to large, long conical, angular; yellowish white, nearly covered with stripes and splashes of bright carmine; cavity narrow and deep, pointed, stem medium; basin narrow, abrupt, folded; eye medium closed. Flesh nearly white, tender and juicy, with a mild sub-acid flavor. Generally quite productive and valuable either for dessert or cooking. Season, September and October.

Keswick.—Tree strong and vigorous. A very early bearer and quite productive; fruit medium to large, oblong conical, truncated, ribbed; cavity acute; stem medium long, slender, deep set; basin medium, irregular, calyx quite large; skin greenish yellow, sometimes with a light blush; juicy and acid, excellent for cooking. It is especially valuable for home use as it can be used from July to November.

Maiden Blush.—A handsome, vigorous and productive spreading tree; fruit medium to large, regular, flattened; pale yellow with a handsome blush of deep carmine covering half the fruit; cavity wide and deep; stem rather short; basin shallow and regular; calyx closed, small; flesh white, tender, sprightly, fine-grained, sub-acid, aromatic. Rather too sharp for most persons as a dessert fruit, but excellent for cooking. An early and sure bearer. Season September and October.

Shiawassee.—Tree a strong, upright grower, becoming somewhat pendent when full grown; young wood reddish brown; fruit medium size, regular, flattened; skin greenish white, nearly covered with stripes and splashes of deep red; basin wide, corrugated, eye medium, close; calyx reflexed; cavity wide; stem short; flesh very white, tender, sprightly, aromatic, pleasant sub-acid; quality very good. A seedling of Fameuse, which it resembles, but the tree is more upright and the fruit is larger, and much less injured by scab than is that variety. Season October and November.

Twenty Ounce.—Tree a hardy, thrifty, compact grower, and a regular bearer; fruit very large, regular, or slightly ribbed, round-conical, smooth; yellowish green, nearly covered with rich red, splashed and striped with scarlet; basin regular, abrupt; eye small, closed; calyx long and reflexed; cavity wide and deep; stem short; flesh white, granular, juicy and rather acid. Rather coarse and of poor quality, but a good cooking apple, while its size and color cause it to sell well. Season October to January.

Bailey Sweet.—Tree hardy, vigorous and productive; fruit large, round or slightly conical, obscurely ribbed; bright red with indistinct stripes on yellow ground; dots large and numerous; basin narrow, abrupt, plaited; eye small, closed; cavity small, narrow, slightly ribbed; stem slender, one inch long; flesh yellow, tender, but not very juicy, mild, rich and sweet. November to February. One of the best of the early winter sweet apples.

Westfield.—Tree strong and vigorous, with fruit on young trees quite free from scab; fruit rather large, round-conical, generally regular; dull red, striped with russet and with yellow dots; stalk slender, three-fourths of an inch long, in a regular cavity; calyx sometimes partly open, in a regular basin of medium size; flesh white, tender, spicy and juicy and of fine flavor. November to February. One of the very best varieties either for home use or market.

Jonathan.—Tree a moderate grower, shoots slender and spreading; fruit of medium size, round-conical, sometimes slightly truncated, regular; yellow, nearly covered with bright stripes of bright red; stem slender, inserted in a deep and regular cavity; basin deep and rather broad; flesh white, spicy, juicy and sub-acid. November to January. On strong soils an excellent variety, bringing the highest price in the market if well grown.

Hubbardston.—Trees strong growing, branching; fruit large, round-oblong, slightly conical; skin yellowish, nearly covered with stripes and splashes of pale and bright red; stalk three-fourths of an inch long in an acute, russeted cavity; calyx open, in a ribbed basin; flesh yellowish, juicy and tender, rich and sub-acid, excellent. November to January. Shoots rather slender, downy and gray. Valuable in every collection.

Grimes' Golden.—Tree vigorous, hardy, spreading and productive; shoots with swellings at the base, dull red, downy; fruit medium size, regular, round-oblong; skin a golden yellow, sprinkled with gray dots; stalk short and slender, in a deep, russeted cavity; basin abrupt and irregular; flesh yellow, fine grained, firm and crisp, with a rich, spicy flavor, sub-acid. November to February. Excellent for home use, but as with other yellow varieties, its color is against it for market.

Baldwin.—Tree strong, vigorous, branching and productive; fruit large, round-ovate, flattened; greenish yellow, nearly covered with crimson, often

russeted, particularly about the stem; stem rather short, varying in size, in an even, rather deep cavity; basin narrow, plaited, calyx closed. Flesh yellowish white, sub-acid, with fair flavor. Tree a vigorous grower and in nearly all parts of the State a profuse bearer. In heavy soils, especially if low and wet, it has been found lacking in hardiness in severe winters. One of the best varieties for all purposes. Season from November to March.

Talman.—Tree very hardy and productive. One of the best cooking sorts. Generally spreading and with stout branches. Fruit round or slightly flattened. Skin yellowish white, with slight blush in the sun and a number of lines from stem to calyx. Stem long and slender, inserted in a wide but shallow cavity. Basin small and but slightly depressed. Flesh white, sweet and of fine flavor. November to March.

King.—Tree vigorous and spreading and generally quite productive. Fruit large, round, conical, slightly angular. Skin yellow, shaded with red and nearly covered with crimson splashes. Stem large and stout, inserted in a large and irregular cavity. Calyx small and closed, in a small corrugated basin. . Flesh yellowish, coarse, but tender and juicy, with a pleasant vinous flavor, decidedly aromatic. Generally a desirable variety. December to March.

R. I. Greening.—Tree very vigorous, with large, spreading branches. Generally a profuse bearer. Fruit large and round, considerably flattened; sometimes slightly ribbed, green, becoming whitish green when ripe, with a dull blush in the sun. Stalk small, three-fourths of an inch long, curved, thickest at the bottom. Flesh yellow, fine grained, crisp, juicy, and with an aromatic, sub-acid flavor. November to February.

Red Canada.—Tree of slender growth and should be top-worked on a vigorous grower. Fruit flattened and generally conical, size medium. Skin yellow, nearly covered with deep red or crimson, generally striped and splashed, and with many large, gray dots. Stem short, in a broad, deep cavity. Calyx closed, segments long, in a small, narrow, and generally irregular basin. Flesh white and crisp, and with a pleasant flavor. Trees bear early and abundantly and need the best of care. Season December to May.

Northern Spy.—Tree a vigorous and upright grower, slow in coming into bearing, but often quite productive when ten or twelve years old. Fruit large, roundish conical, generally ribbed in the larger specimens. Skin greenish-yellow, about one-half covered with stripes of dull red, with a few pale dots and a thin, white bloom. Stem three-fourths of an inch long in a wide, deep cavity, sometimes marked with russet. Calyx small, closed. Basin narrow, furrowed. Flesh white, fine grained, tender and slightly sub-acid, with a pleasing flavor. Quality very good to best. December to June.

Golden Russet.—Trees vigorous and spreading, generally with small, drooping shoots. Fruit of medium size, round or slightly flattened, conical. Skin rough, yellow, nearly covered with russet and with a bronze cheek in the sun. Stem short, small, in a medium, deep cavity. Calyx closed, segments long. Basin large, broad and corrugated. Flesh yellowish white, firm, mild, sub-acid. Quality good. Generally productive. December to June.

It has been observed that orchards where only one variety is planted are often unfruitful. The observations of the National Department of Agriculture have shown that this is because many varieties are not self-

fertile, or in other words that pollen from another variety is required for the proper fertilization of the flowers and setting of the fruit.

For this reason we would advise that in large commercial orchards, unless one is sure that the varieties selected are self-fertile, several varieties should be grown, and that no more than five or at most ten rows of any one variety be planted without introducing at least one row of some other kind. While this will to some extent injure the appearance of the orchard, and perhaps increase the labor in picking, the benefits to the crop will more than balance these drawbacks.

The same thing is known to be true of pears to an even greater degree and is probably true of other fruits.

LAYING OUT AND PLANTING THE ORCHARD.

In locating the position of the trees a garden line or wire, with a mark of some kind at the interval determined upon for the trees, should be used, and stakes set where the trees are to go. To secure the placing of the trees at the precise spots occupied by the stakes, a planting board of some kind can generally be used to advantage. A simple form is shown in Fig. 5. It consists of a strip of board three or four inches wide and six feet long, with a notch at each end and another in the middle.

Fig. 5.—Planting board.

To use the board, place the center notch against the stake where the tree is to be set and insert stakes at each of the other notches. The board can then be removed and used at other trees in the same way. When the hole for the tree has been dug, the board is again placed so that the stakes will be in the end notches, and, if the tree is placed in the center notch, it will be in exactly the same position that the original stake occupied. In this way, if the land is carefully marked out, it will be a simple matter to have the trees in straight lines.

If, before setting the trees, the land is deeply plowed, the holes need be only large enough to receive the roots without crowding, but if this has not been done it will be well to make them three or four feet in diameter. Should it become necessay to set trees in land that for any reason is not adapted to them, it will aid them in making a start if the holes are made large and rich loam is used for filling them.

Before setting the trees, the roots should be examined, and if any of them are large and have been bruised or have rough ends, they should be cut smoothly off. Also if they have a mass of small hair-like roots, and especially if these have become dry, it will be well to remove them. The holes should be deep enough to allow the trees to stand an inch or so deeper than they were in the nursery. As a rule, they should be deeper on light soil than when it is heavy and poorly drained. Having adjusted the tree in the center notch of the planting board and spread the roots out evenly, the fine soil should be slowly thrown in and carefully worked among the roots, taking pains that no cavity is left beneath the tree. As soon as the roots have been covered the soil should be firmly pressed upon them, using either the feet or a wooden tamper. About three-fourths of the hole should be filled in this way, but it is better to leave the surface

soil light to act as a mulch and prevent evaporation. As a rule the soil about the trees should be left level, although in spring planting, if the land is rolling, a slight depression may be formed which will catch the water that would otherwise run off.

In handling the trees care should be taken that they are not exposed for any length of time to the action of the sun or wind, and while planting it will be desirable to heel-in the trees until needed, by covering the roots with soil, unless canvas or other coverings are used.

WATERING THE TREES.

If the soil is fairly moist it will not be necessary to apply water to the trees at the time of planting, but if a drouth prevails the use of water will generally be desirable. Even though the soil is fairly moist, water will often make the trees more likely to start into growth. To use water in transplanting trees to the best advantage, it is well to cover the roots as recommended above and then fill up the hole with the water. As soon as it has soaked in, the remainder of the soil should be placed in the hole. If at any time it becomes desirable to add more water, it is a good plan to scrape away the soil from around the trees so as to form a basin from four to eight feet in diameter according to the size of the trees, and into this from ten to forty gallons should be turned, replacing the soil as soon as the water has been taken up.

FORMING THE HEAD.

As soon as the trees have been planted they should be pruned and the heads formed. When branched trees are used, the first thing is to remove all surplus shoots, selecting the weaker ones and leaving four or five of the others arranged at intervals along the stem. Beyond this it is not necessary to go, but if the remaining shoots are long and slender it will be well to head them in from one-fourth to one-half. The center shoot should be left considerably longer than the others, to grow upward and develop other side shoots. A tree formed in this way with its branches given off at intervals from a central axis is much less likely to break down than when they start at the same height.

When one-year trees without branches are used, it will only be necessary to cut back the trees at the proper height for the branches to form. A variety of opinion exists among fruit growers as to the proper height for an apple tree, but as years go by it would seem as though the better fruit growers were becoming quite unanimous that it is a mistake to have very high heads. The only exception to this rule is in sections where the snow-fall is heavy and there is danger of the branches being broken down if they are within three or four feet of the ground.

While varieties with a spreading habit may require a greater height of trunk, for the upright growers three feet is perhaps a fair height for the lower branches, while some head even lower than this.

Among the reasons for having low heads is that the branches can then prevent the burning of the bark by the sun during hot weather, also that the wind will be much less likely to turn it from the perpendicular. It will also be easier to prune and spray the trees and gather the fruit than when they have high trunks. About the only objection to low heads is that they interfere with cultivation, but if the side shoots are properly pruned this need not be the case.

PRUNING THE TREES.

If pruning begins in time, and is thoroughly done while the trees are small, it will greatly lessen the necessity for the removal of the large branches later on, and will thus lengthen their life. During the first two or three years the surplus shoots that start should be rubbed out and all branches that get much beyond their fellows should be cut in. As the trees increase in size all shoots should be removed from the main branches so that there will be no side branches within four or five feet of the main trunk.

While no general rules can be given for pruning that will apply in all cases, the following will be found useful: (1) Remove all dead branches as soon as they appear, cutting them back to sound wood. (2) Keep the head open enough to admit of the easy gathering of the fruit, and the entrance of the air and sunlight to the leaves and fruit on the inner branches, but avoid the opening up of the heads so as to allow the sun to enter and strike with full force upon the naked stems and branches. (3) Prune so as to secure a symmetrical head to the trees. By proper pruning a portion that is weak can be made to fill out, while the strong growing branches can be restrained. (4) If a low, spreading variety has a tendency to carry its branches too near the ground and thus prevent cultivation, it is not necessary to cut them back to the trunk, as a point can generally be found where a side branch has an upward tendency, and if the end is cut off to this point the trouble will be obviated.

When the only pruning required is the rubbing out of surplus shoots or such cutting out as can be done with a knife, it can be done at any time, but, if it has been delayed until a saw is required, care should be taken that a suitable time is selected. While pruning may be done in any month while the leaves are off from the trees, it will generally be preferable to prune young trees during the latter part of March or the first half of April. If delayed until the sap starts, harm is often done by the sap running down the trunks and injuring the bark. Pruning at this time has a tendency to cause a development of stem and leaf, while if performed after growth has started a check is given to the growth of the trees and a development of fruit buds is promoted. For trees that have reached a bearing age, and owing to their strong growth have formed no fruit spurs, it is a favorite practice with some persons to delay the pruning until the leaves have appeared, say about the middle of May, and then give the necessary pruning.

Wounds made in the fall or winter become dried out and are much slower in healing over than those made in the spring and early summer, which is an added reason for spring pruning. If at any time it becomes necessary to remove large branches, the wound should be at once covered with paint or other material that will prevent it from drying out. By coloring it so that it resembles the color of the bark it will be less unsightly.

CULTIVATING THE ORCHARD.

It is generally admitted that some hoed crop should be grown in young orchards. In making the selection it is best to choose one that will require frequent cultivation up to the first or the middle of August, and that will not necessitate the stirring of the soil to harvest it until after the middle of October. Corn, late potatoes, squashes and beans are among

the crops that satisfy the above conditions. The small grains are least of all adapted to the successful growth of the orchard, as they not only require large amounts of water and plant food, at the time when it is required by the trees, but they allow the soil to bake, and thus a large amount of water is wasted by evaporation. For the same reason grass and most forage crops are not suitable for the orchard, especially while the trees are small.

Under ordinary conditions it will be well to give similar care to bearing trees, until they become so large that hoed crops cannot be grown among them to advantage. After that time if the entire land is given up to the trees the increased profits from the crop of apples will more than equal the value of the hay or grain crop that could be obtained and the expense of the cultivation they would need.

While by the use of manure or fertilizers a supply of plant food could be furnished both to the trees and the other crop, the amount of water available would seldom be sufficient for the apple crop alone, were no means taken to conserve it by frequent stirring of the soil. The trees would then make a small growth, form few fruit buds, and the fruit crop would be small in quantity and inferior in quality.

While no deviation from the above rule should be made in the case of young trees, there may be circumstances that will make it desirable with bearing orchards to seed down the land for a year or two. The grain crops should even then be avoided, but if the trees have reached a bearing age and are making such a strong growth that few if any fruit buds are formed, the land can be seeded to clover or grass and the desired check can thus be given. Upon rich, strong land, especially if there is an abundance of moisture, the sod will not be particularly injurious, and if clover is grown it will add to the fertility of the land. It will seldom be desirable to allow the sod to remain for more than two years.

Upon light soils, where it will be difficult to secure a catch of clover, it is not a bad plan to sow rye in the orchard in August and turn it under the following May. This will be a slight protection during the winter and will add to the humus of the soil when it is turned under.

Where crimson clover is hardy it is an ideal crop for this purpose, but it is doubtful if it can be successfully grown in most parts of the State. As grown here for a number of years, very few plants survive the winter. It may in time become acclimated and, even now, is perhaps worthy of trial, sowing American seed grown as far north as it can be secured at the rate of ten pounds per acre in August.

Upon many farms where hogs are raised, the orchards are used as hog pastures. If they are given plenty of food or have a considerable range they seldom injure the trees, and as they keep the ground cultivated and destroy the apple worms by eating the fallen apples they serve a good purpose. If the range is so large that they cannot keep the surface well worked it is well to supplement their work with the cultivator. Sheep can also be used in old orchards in a similar manner.

Some advocate keeping the land in grass and allowing it to fall down and remain on the land. While this will not directly take plant food from the trees, it will virtually have the same effect by lessening the amount available for them by aiding in the evaporation of moisture from the soil. The presence of the grass will also make harboring places for insects and vermin.

When orchards are cultivated without crops, it will be well to plow the land in the spring, if it is inclined to be heavy, and then at intervals of a week or ten days during the summer give it a stirring with some form of harrow or orchard cultivator. For this purpose, when the soil is light, we have used with good results the Acme harrow.

When the trees are large and it is desirable to work beneath them the Pearce orchard cultivator will enable one to work the ground two or three feet farther under the branches than the team can be driven.

Of the newer implements that are coming into favor is the Morgan orchard cultivator. This has been quite extensively used for several years and is generally highly spoken of.

In case the land is well drained it is best to give it level culture during the summer, working away from the trees the soil that was turned towards them when the land was plowed in the spring.

The tillage is of advantage to the trees in various ways, as it opens the soil and thus favors the admission of water which might otherwise run off; it admits the air more freely and in this way aids in the solution of plant food in the soil; the roots also are able to penetrate it more readily. Perhaps the principal gain is in conserving the water that is in the soil and preventing its evaporation. By keeping the surface soil to the depth of two inches light and open, the amount held in the soil will be increased nearly one-half. This will be of great importance to the crop and in dry seasons will be equal to the addition of thousands of barrels of water to each acre of the land.

When the land is not to be cultivated it is well to place a mulch of some kind around newly planted trees to prevent loss of water.

Although it answers for this purpose, there is a serious drawback to the use of a mulch, as it draws the roots into the surface soil and renders them more likely to be injured by the winter.

MANURES AND FERTILIZERS

One of the essentials for the successful growing of an orchard is the presence of an abundance of plant food. While land that will grow a large corn crop will have plenty of food for young trees, there are few soils that will not be benefited by an application of manure after the trees come into bearing, and if the land is heavily cropped it will generally be desirable when the trees are two or three years old.

Until the trees reach a bearing age, we need not think of using commercial manures so long as an abundance of stable manure can be obtained. From fifteen to twenty loads to the acre applied broadcast once in two years will supply any ordinary farm crop and provide food for the growth of the trees. If the trees alone are to be manured, it will not be desirable to cover all of the land with manure until the trees have reached the age of ten or twelve years. The amount used should depend on the size of the trees and should be placed over a circle with a diameter about twice that of the heads of the trees. The banking of manure about the trunks is unwise, as the feeding roots are for the most part several feet away. Upon bearing trees it is generally as well to leave a considerable space about the trunks without manure, and it is better to have the entire amount outside the circle of the branches than to have it packed about the tree.

While stable manure is desirable for young trees, it contains such an excess of nitrogen that if used by bearing trees it should be supplemented by some form of potash and phosphoric acid. While it is less likely to be injurious to apple orchards than to some of the more tender fruits, the excessive use of stable manure, especially if it is in an undecomposed form, is likely to cause a rank, late growth that may be injured by the winter. Nitrogenous manures also tend to promote growth of stem and leaf and this will be at the expense of the fruit.

While stable manure then can be used to advantage upon poor soils for young trees, it should be used somewhat sparingly for bearing orchards that are growing in soils fairly rich in plant food. There are, however, few soils where trees will be injured by stable manure, and one need not hesitate to make applications up to thirty or forty loads of stable manure per acre, where the trees have been grown for years without manure.

Of the mineral manures wood ashes will be found to be the cheapest source of potash and they also supply some phosphoric acid. Their value will depend upon the kind of wood from which they were obtained, the amount of foreign matter they contain and the extent, if any, to which they have been leached. Hard wood ashes are worth perhaps one-half more, pound for pound, than those from soft wood and, while no definite rule can be given that will fix the value of leached ashes, it is seldom safe to count them as more than one-third as valuable as unleached ashes.

An average sample of unleached ashes should contain about five per cent of potash and one and one-half of phosphoric acid. This will make a bushel of ashes worth about ten to fifteen cents, according to the amount of water they contain, as compared with what chemical manures will cost. At this valuation they will be worth from five to six dollars per ton, although ashes of a known high analysis might be worth nearly twice as much.

For bearing orchards from fifty to one hundred bushels per acre can generally be used to advantage, with smaller amounts for young trees. While the trees are quite small one peck to each will generally be sufficient. In case soft wood ashes or those that have been leached are used the amount should be increased in proportion.

Besides their value in supplying plant food, wood ashes have a physical effect upon light soils that is of value. The carbonates of potash and soda contained in wood ashes tend to bind together the particles of soil and make it more compact. While this is of value upon sand, it has the reverse effect upon very heavy soils, especially if a considerable excess of ashes is applied.

In sections where wood ashes cannot be readily obtained, the German potash salts can be used with profit. They can be obtained either as sulphates or muriates, and generally contain about fifty per cent of potash.

The price in New York is from forty to forty-five dollars per ton. As one ton of potash salts contains as much potash as ten tons of wood ashes, it can be seen that they will be much cheaper to transport and to apply. For young trees one to two pounds will be sufficient, while two to four hundred pounds per acre will be ample for bearing orchards.

Potash has the effect of promoting a firm growth of wood which is favorable to the production of fruit buds and renders the trees less likely to winter-kill.

While phosphoric acid can be obtained from a number of sources, for trees it is best to use ground bone. This can be obtained at about twenty-

four dollars per ton and provides a cheap source for this material. It is slowly soluble and its effects can be seen for several years. Of ground bone from two to five pounds will be sufficient for young trees, while those in full bearing will require from five hundred to one thousand pounds per acre, if they are of a large size and cover all of the ground.

Another source of phosphoric acid is the dissolved rock phosphate from South Carolina. They are less valuable than the bone phosphates and the transportation charges render them little if any cheaper. As compared with ground bone, the "odorless" and other iron phosphates cannot be recommended for most localities.

Nitrate of soda is the best source for nitrogen in a mineral form, but where stable manure can be obtained it will have little use. Trees will seldom need more than one to two hundred pounds of this material per acre.

It will generally be desirable to supply both potash and phosphoric acid to the apple trees and the ground bone and potash salts can be mixed and applied together. As a rule it will require two pounds of the ground bone to each pound of potash salts. When ashes are used with ground bone, it will be well to apply one to two bushels of unleached ashes to each ten pounds of ground bone.

RENOVATING OLD ORCHARDS.

Nearly all of the orchards in the State are in sod, and are in anything but a flourishing condition. They have for the most part been allowed to shift for themselves and as a result have become "hide-bound" and make but little growth and produce still less fruit.

We are often asked to recommend a course of treatment for such orchards, but the conditions vary to such an extent that what might be desirable for one orchard might not be required in another. In a general way supposing the conditions to be as stated, we would make the following recommendations.

(1.) Cut down all trees that have gone so far beyond their prime that they have badly decayed trunks and only one or two broken branches.

(2.) From trees that have healthy trunks and promise to in a measure renew their youth if given proper care, remove all dead or dying branches, thin out surplus shoots where absolutely necessary and attempt to bring the trees into good form. If they are badly misshapen it may be well to cut the stronger branches back severely in order to force the others into growth. If a tree of some worthless variety is fairly healthy and vigorous, it may pay to top-graft it with some desirable sort. The branches should be cut back so that they will be about one and one-half inches in diameter and two cions inserted in each stub. As a rule it is best to extend the operation over two or three years and thus lessen the check to the tree.

(3.) If the land has not been manured, as will generally be the case, it should receive an application of twenty to thirty loads of decomposed stable manure. The land if in sod should then be plowed, taking care to injure the roots no more than is necessary. For at least two years the land should be cultivated, either with or without hoed crops. Fifty to one hundred bushels of wood ashes per acre can generally be used to advantage.

(4.) If the trunks of the trees are covered with a thick layer of dead bark it will be well to remove it, taking care not to scrape into the living bark beneath. The trunks should then be washed with soft soap thinned

with water to a thick paint. If borers are present a teaspoonful of sulphur and of carbolic acid to a gallon of the soap mixture can be added to advantage.

(5.) Spray the trees with the approved remedies for the insects and fungous diseases that attack the apple. Good results cannot be expected unless a perfect and healthy foliage is preserved, and the fruit will be of little value unless it is protected from the ravages of the codling moth and the apple scab.

The above treatment is of course only suggestive, but, as most orchards will be benefited if handled as recommended, it is submitted for consideration.

INSECTS AND DISEASES.

The more troublesome insects and diseases of this fruit are described in Bulletin 121 and remedies for their destruction are there given.

The following spraying calendar for the apple is here inserted as the other bulletin may not be at hand:

Treatment for Insects and Diseases of the Apple.

(Canker worm, Codling moth, Bud moth and Apple scab.)

First application, spray before buds start using copper sulphate solution.

Second application, after the blossoms have formed, but before they open, spray with Bordeaux mixture and Paris green.

Third application, within a week after blossoms have fallen, use Bordeaux mixture and Paris green.

Fourth application, ten to fourteen days later, repeat.

Fifth application, twelve to twenty days later spray with Bordeaux mixture.

It may be well to state that the Paris green is for the destruction of any insect, such as the canker worm, codling moth or bud moth, that may eat any exposed part of the tree or fruit, while the Bordeaux mixture is only used as a fungicide for the destruction of the apple scab or any of the other fungous diseases to which the trees are subject. The first application is intended to destroy any mycelium of the apple scab that may have wintered over upon the branches. With the second it is intended to coat with a fungicide the foliage and particularly the blossoms and blossom stems, thus rendering them safe from the entrance of the germs of the fungus, while the Paris green is intended to destroy the canker worms that are likely to appear while the trees are in blossom. The third application is to destroy the larvæ of the codling moth, before they enter the fruits and to again provide for the protection of such parts of the tree as are not covered with a fungicide. The fourth application is for a similar purpose, while the fifth is to protect the fruits from the scab.

In many cases and for most varieties, it will not pay, perhaps, to give the five applications, but if canker worms and apple scab are troublesome the second should not be omitted and in nearly all parts of the State the third and fourth applications can be made with profit.

ARSENIC AS A SUBSTITUTE FOR PARIS GREEN.

For the fact that white arsenic is a dangerous thing to have around, from its resemblance to such harmless household chemicals as salt, soda and baking powders, as well as the trouble required in preparing it for use and the danger of burning the foliage if not properly prepared, we have hesitated about recommending it for general use as an insecticide. During the past two years the price of Paris green has more than doubled and owing to the ravages of the canker worm the necessity for the use of arsenites has greatly increased, and as a matter of economy to farmers and fruit growers we give a method of preparing arsenic for use that will furnish a remedy against chewing insects at less than one-fourth the present price of Paris green. As pure Paris green contains only about one-half the arsenic found in white arsenic it will be seen that the latter will go twice as far and besides it is more likely to be free from adulteration.

To Prepare Arsenic for Spraying.

1 pound of arsenic.
2 pounds of fresh lime.
400 gallons of water.

Boil for twenty minutes in two gallons of water one pound of white arsenic and two pounds of lime that has been carefully slaked. A light, white precipitate will gradually form. White arsenic dissolves slowly even in boiling water, but the lime unites with it as it dissolves and takes it out of solution, so that a small amount of water will answer for the purpose. The white precipitate formed is arsenite of lime, which is the same as London purple without the coloring matter. This is nearly insoluble and, as in the case of London purple and Paris green, the lime used with it prevents injury to the foliage. If desired the water can be poured off and the precipitate can be kept for future use. Before using the arsenic dilute to four hundred gallons. As Paris green now sells for thirty cents per pound at retail while white arsenic can be bought for ten or twelve cents and will go twice as far, it can be seen that it will be much the cheaper to use.

There will be no danger of burning the foliage if the boiling was kept up until all of the arsenic was dissolved and rendered insoluble by the lime, but if this was not done it will be likely to do injury. Until one has had experience in making the solution it will be well to test the material upon a small scale before applying it to the orchard.

The above method of making the arsenite of lime was given in Bulletin 77b of the North Carolina Agricultural Experiment Station.

Dr. Kedzie recommends the following method of preparing it: Boil in one gallon of water one and one-half ounces of white arsenic and five ounces of sal-soda. This will quickly dissolve and the fact can be observed, while in the other way it cannot readily be determined. Add two pounds of lime and dilute to forty gallons with water.

This amount of lime furnishes a large excess, but will do no harm and may be of advantage.

If the arsenic in any form is to be kept, it will be well to color it with soot, lamp black or some other material so that it may not be mistaken for harmless chemicals.

COMPULSORY SPRAYING LAW.

The ravages of the various insects and diseases of our fruits has become so great that, at the instance of many of the leading fruit growers, the following bill was introduced at the present session of the State Legislature, by Representative Graham of Grand Rapids, who is himself a large fruit grower, and has just received the signature of the Governor. As its terms are explicit no comment is necessary.

AN ACT to prevent the spreading of bush, vine and fruit tree pests, such as canker worms and other insects, and fungous and contagious diseases, and to provide for their extirpation.

Section 1. The People of the State of Michigan enact, That it shall be the duty of every owner, possessor or occupier of an orchard, nursery or vineyard, or of land where fruit trees or vines are grown, within this State, to spray with a poisonous solution or disinfectant of sufficient strength to destroy such injurious insects or contagious diseases, all fruit trees or vines grown on such lands which may be infested with any injurious insects or worms, or infected with any contagious disease known to be injurious to fruit or frnit trees or vines: Provided, That no such spraying shall be done while said fruit trees or vines are in blossom, except in case of canker worms.

Sec. 2. In any township in this State where such injurious insects or contagious diseases are known to exist, or in which there is good reason to believe they exist, or danger may be justly apprehended of their introduction, it shall be the duty of the township board upon the petition of at least ten freeholders of such township to appoint forthwith three competent freeholders of such township as commissioners, who shall hold office during the pleasure of the board, and such order of appointment and of revocation shall be entered at large upon the township record: Provided, That in townships having a board of yellows commissioners, such commissioners shall be ex officio commissioners under this act.

Sec. 3. It shall be the duty of said commissioners within ten days after appointment as aforesaid, to file their acceptance of the same with the clerk of said township, and said clerk shall be ex officio clerk of said board of commissioners and he shall keep a correct record of the proceedings of said board in a book to be provided for that purpose, and shall file and preserve all papers pertaining to the duties and actions of said commissioners, or either of them, which shall be a part of the records of said townships.

Sec. 4. It shall be the duty of said commissioners or any one of them, upon, or without, complaint, whenever it come to their notice, that any orchard, fruit trees or vines are infested with canker worms or other injurious insects or contagious diseases, within their townships, to proceed without delay to examine such orchards or vineyards supposed to be infested, and if such injurious insects or contagious diseases are found to exist, the owner shall be notified personally, or by a written notice left at his usual place of residence, or if the owner be a non-resident, by leaving the notice with the person in charge of the trees or vines, or the occupant of the lands upon which such trees or vines shall be growing. The notice shall contain a simple statement of the facts as found to exist, with an

order to effectually destroy such injurious insects or worms or contagious disease by spraying such trees or vines with a poisonous solution, or in case of contagous disease to effectually disinfect said diseased trees or vines, within such time from the date of the service of the notice, as such commissioners shall designate, said notice and order to be signed by the full board of commissioners.

Sec. 5. Whenever any person shall refuse or neglect to comply with the order to spray or disinfect the orchards or vineyards designated by the commissioners, as aforesaid, it shall become the duty of the commissioners to cause said trees or vines to be effectually sprayed with a poisonous solution or disinfected as occasion should require, forthwith, employing all necessary aid for that purpose, and the expenses for the same shall be a charge against the township, and for said spraying or disinfecting, the said commissioners, their agents or workmen, shall have the right and power to enter upon any and all premises within their township.

Sec. 6. If any owner, township officer, or commissioner, neglects or refuses to comply with the requirements of this law as set forth in the preceding sections and within the time therein specified, such persons shall be deemed guilty of a misdemeanor, and punished by fine not exceeding fifty dollars or imprisonment in the county jail not exceeding sixty days, or by both such fine and imprisonment in the discretion of the court; and any justice of the peace of the township where such trees or vines may be growing shall have jurisdiction thereof.

Sec. 7. The several commissioners shall be allowed for service under this act, two dollars for each full day, and one dollar for each half day, and their other charges and disbursements hereunder to be audited as well as any other charges and disbursements under this act, by the township board, all of which costs, charges, expenses and disbursements shall be recovered by the township from the owner of said infected or infested orchards or vineyards from the owner of the premises on which said trees or vines may be growing, in an action of assumpsit. The provisions of this act shall not apply to the contagious disease known as yellows.

This act is ordered to take immediate effect.

In sections where the danger from the various parasitic diseases and insects of our fruits is sufficiently understood to secure the enforcement of this law, it cannot fail to result in great good to all.

L. R. TAFT.

AGRICULTURAL COLLEGE, MICH.,
May 1, 1895.

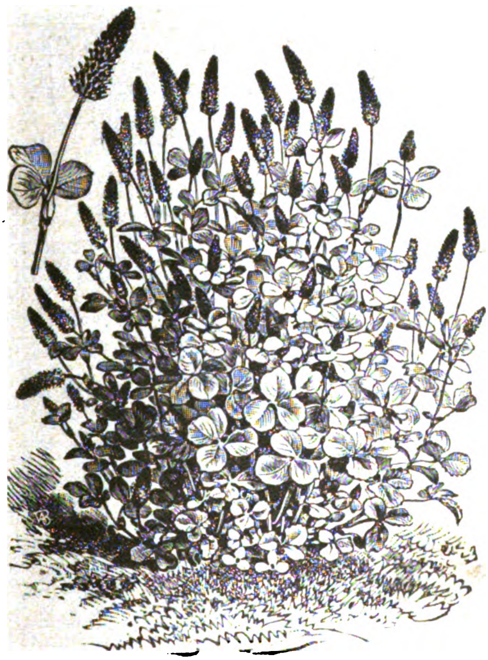
BULLETIN 125 JUNE, 1895

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

FARM DEPARTMENT



CRIMSON CLOVER AND OTHER TOPICS

A. A. CROZIER.

AGRICULTURAL COLLEGE, MICHIGAN
1895

FARM HOME READING CIRCLE

OF THE

MICHIGAN AGRICULTURAL COLLEGE.

The Michigan Agricultural College maintains a college extension course of reading designed especially for farmers, gardeners, fruit growers and stock breeders. This course is open to all who are interested. The college is especially earnest in its desire to bring the college nearer to the farmer by a thorough dissemination of the latest knowledge relating to agriculture. We invite the co-operation of all progressive farmers in this matter. The Farm Home Reading Circle offers a course in systematic reading on subjects of practical interest to every farmer. The expenses of maintaining the course are paid from a special appropriation by the State Board of Agriculture. There are no expenses to members except the purchase of books. We have already a large and rapidly increasing number of readers and the enthusiasm of those who have taken up the course is very gratifying. Send a postal card for full information.

L. G. GORTON,
President of the College.

F. B. MUMFORD,
Agricultural College, Mich.

BULLETIN 125 **JUNE, 1895**

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

AGRICULTURAL DEPARTMENT

CRIMSON CLOVER AND OTHER TOPICS

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BY A. A. CROZIER

AGRICULTURAL COLLEGE, MICHIGAN
1895

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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MRS. L. E. LANDON,	Librarian.
T. T. LYON, So. Haven,	In charge of Sub-Station.
R. L. TAYLOR, Lapeer,	In charge of Apiary.

SUB-STATIONS.

Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.

CRIMSON CLOVER AND OTHER TOPICS.

CRIMSON CLOVER.

This clover is an annual, living but one year. If sown in the spring it makes a small growth, comes rapidly to maturity, ripens its seed the same season, then dies. If sown during the summer or early fall it develops more slowly and, where the winters are not too severe, lives over, completes its growth and matures its seed the next year. Sown late in the season it attains a larger growth than when sown in the spring, besides occupying the land at a time when it is not required for other crops. In Delaware, Maryland and other states where this clover is successfully grown, this is the time of sowing nearly always recommended and adopted. The advantages of a clover which will succeed when sown late after certain crops have been harvested, and which will come on so as to be cut for hay or turned under as a fertilizer the following spring in time for other crops that year are obvious, and where Crimson clover will do this it is not surprising that it has become popular. The chief doubt in regard to its success in Michigan has been as to its ability to withstand the winters. Crimson clover is a native of Italy and other parts of southern Europe, while red clover, mammoth clover and Alsike range in their native state farther north on that continent. Crimson clover is not new to this country but has only recently begun to attract general attention here. Last year for the first time it was sown in sufficient quantities in Michigan to furnish any satisfactory evidence as to its probable success in this state. The following statements have therefore been collected this spring (1895), consisting almost entirely of the experience of persons who sowed this clover the past season:

H. B. Cannon, Washington, Macomb Co., April 30:

We obtained our seed from E. H. Bancroft, Camden, Delaware, and sowed it August 29 among standing corn. The first week in September there were good rains and the clover got a good start. We would have sowed the seed earlier had there been prospects of rain. We sowed some five acres, twelve pounds of seed to the acre—soil a clay loam. The clover grew while there was a chance, especially well on the more moist places, but it did not get very large before winter set in. I noticed it in January before the heavy snow came. It was then getting along well save that the frosts had lifted the crowns badly in places. The plants were of the same size, or a trifle larger, than those of medium clover, sown the previous spring, growing in a neighbor's wheat stubble adjoining. When the snow left us I noticed that the clover looked well in places but that it was dying or dead on the ground where it had been lifted. The long dry spell till the present has finished the stand, save in the lower ground where the

plants are growing. The field lies rather low and is partly drained. The clover is all alive along the lines of tile. I noticed that the dead plants had very long roots, but the ground cracked too deep for them this spring. I will sow a little more seed this coming August, hoping to have better success.

C. M. Bowen, Chelsea, Washtenaw Co., April 28:

I sowed about one acre of Crimson clover last fall in my apple orchard. It got a good start in the fall and passed the winter all right up to about March 15, when the freezing and thawing were too much for it. I shall sow it again tomorrow and see what it will do.

Willis F. Anderson, Devil's Lake, Lenawee Co., May 14:

I sowed two plots of Crimson clover last year. One on seven-eighths of an acre, August 6th, on sandy soil containing some gravel. We had a light shower about the time it was sown and it started fairly well. Where it was protected by the snow around the edges of the field it is now 18 to 20 inches high. Through the middle of the field it has not done so well, being from 4 to 8 inches high. I also sowed a field of six acres on a somewhat rolling, sandy, gravelly soil some time in September. We had no rain, yet some of the seed came up, but not enough for a stand. I am pleased with the little success I have had and shall sow this clover again this season but shall sow it earlier. I think it will stand as much cold as Red clover.

E. C. Abel, Sand Lake, Lenawee Co., May 20:

Last fall I purchased one pound of Crimson clover seed, diamond brand, from A. N. Brown, Wyoming, Delaware, and sowed it on dry, loamy soil September 6. The ground had been in corn and I covered the seed with a cultivator about two inches deep. On account of being sown late it did not get a large growth last fall, but it did not winter-kill, in fact it withstood the winter much better than Red clover that was sown at the same time and in the same way by the side of the Crimson. The Crimson is about eight inches high at this date and is just beginning to head. After it gets acclimated, and if sown in July or August, I believe Crimson clover will do well in Michigan.

D. Woodward, Clinton, Lenawee Co., May 21:

I sowed one and one-half bushels of Crimson clover seed Sept. 6, 1894. It came up in three or four days but the extreme drouth which prevailed with us immediately diminished the stand and continued to do so all the fall, indeed we have not had rain until this week to wet the roots, yet I have considerable Crimson clover now in bloom. All that showed life when it froze up is alive this spring. It was sown in an orchard, on rolling land, with exposures east, west, north and south. On the clay it failed, but on sand I now have it looking well on a western slope where the wind kept the soil free from snow; none winter-killed. I am now plowing it under and have enough to well pay for the seed. I shall sow twenty acres in an orchard this year the last of July or the first of August providing the soil is moist enough to germinate it.

R. W. Bailey, Hillsdale Co., in Michigan Farmer, June 15:

September 1, 1894, after corn cutting, I harrowed with a spring tooth harrow and sowed one peck of seed per acre. It made a small growth in the fall but covered the ground fairly well when snow fell. In the month of March, 1895, it was alive and nice but the cold and dry winds of this spring have killed it out entirely except on one side where the snow drifts lasted later in the season.

Frank Hodgman, Climax, Kalamazoo Co., April 25:

I sowed Crimson clover last fall in a variety of ways. I sowed two acres August 7, on oat stubble in a clay loam, partly gravelly. I dragged the stubble first with a spring tooth harrow and harrowed it after seeding. The ground was very dry and it was not until Sept. 10, that we got rain enough to wet up the surface of the ground. After this the clover came up and a thick crop of volunteer oats also. The clover had not more than three or four leaf-stalks when winter came. It lived through February and when the first warm days came in March it began to grow rapidly, but by the second week in April it was all dead, which I attribute to the constant freezing and thawing to which it was subjected during the whole of that time. Mr. W. H. Sheldon on the adjoining farm had a thirty acre field of Red clover not a stalk of which survives. I also sowed some small patches of Crimson clover among my corn on a richer, darker soil, burr oak land adjoining prairie. These pieces were all sown about the same time, some of them before the last cultivation, some after. Only a small part of that sown after cultivation ever came up. That sown where the ground was cultivated afterward most of it came

up and made a better growth than that sown on the oat stubble, but was quite small when winter set in. It, like that sown on the oat stubble, went through the winter all right although it was frozen into a solid sheet of ice from January 21, until nearly the middle of March. The freezing and thawing weather killed most of it in the latter part of March, but a few patches on the highest ground sloping to the south lived through it all, and when I plowed it up last week it had made a perfect mat on the ground and was up six inches high. Twenty acres like that would have made magnificent pasture. I shall try it further.

S. Cummings, Galesburg, Kalamazoo Co., May 6:

It was so very dry last season that I got a poor catch. I sowed two acres in buckwheat on rather exposed rolling land. What few plants were alive in the fall have stood the winter all right. If we get rain this year in July and August I shall sow some in corn and cultivate it in.

John E. Dunham, Oshtemo, Kalamazoo Co., April 26:

We had two pieces of Crimson clover, covering together about one and one-half acres, which were sown the last of August; one was on level ground the other a hill side. The first piece stood the winter poorly, in fact there is very little clover left at this writing. The other stood the winter well and is green and thriving now. Our soil is a sandy loam.

I. R. Dunning, M. D., Benton Harbor, Berrien Co., May 17:

Crimson clover did poorly with me but I have not lost faith in it and shall try it again. I had good seed but the winter and the soil were against it. I sowed three patches, one of two acres in corn on light sandy soil that had been run for years and was in an exposed situation so that the wind blew off most of the snow. This patch was sown in August but on account of the drouth it did not come up for about four weeks. It is now in bloom, standing about eight inches high in patches, about three-fourths being killed. It came up thick enough last fall but made little growth. Another patch of four acres on good soil, sown among corn, is doing much better but is not more than one-third of a crop. Another piece of four acres was sown near Grand Rapids, but I have not heard this spring what its condition is. I also sowed about ten acres of rye on a light sandy soil, which gave me good results, turning under quite a heavy rye sod the first of this month. About six acres of the rye and the first two acres of the Crimson clover were top dressed in March at the rate of three hundred pounds per acre with the Jerecki fish fertilizer, made in Sandusky, Ohio.

Freeman Franklin, Buchanan, Berrien Co., May 18:

I bought of Mr. Bancroft three bushels of Crimson clover seed which he advised me to sow the first of August among the corn at the last plowing, but it was so dry I waited until it rained, about the last of August. The rain was accompanied by a heavy wind which blew my corn down so that I could not sow the clover until the corn ripened and was cut up about September 1. I then harrowed the ground with a spring tooth harrow and sowed the seed, but it was then so late it did not make a growth of over one and one-half inches before cold weather. Where the snow remained during the winter the clover lived through but came out in the spring rather feeble, and the alternate freezing and thawing in March and early April killed what was left. The surface was rolling and the soil a gravelly loam. I do not consider the experiment a fair test of the clover. Just to see how it would winter I sowed a spot about ten feet square in my garden about the middle of August. This came up all right and made quite a growth before cold weather and wintered over and is now in full bloom about one foot high.

E. E. Woodford, Niles, Berrien Co., May 18:

I purchased some Crimson clover seed of A. N. Brown, Wyoming, Delaware, last summer, and the last of August plowed up four acres of rye stubble, and on Sept. 1st sowed the clover. The soil was sandy and the location bad for any kind of a crop, being on a knoll. The clover came up well and was all right until the freeze in March, which killed it. I had tried for two years to get a catch of Red clover on the same ground without success. I also sowed a small strip along the roadside, on what might be called bottom land, about five or six rods from a creek, where I had taken out some willows and hazel brush. This piece did nicely. Another piece about four rods square, also near the creek, was sown where the top soil had all been removed leaving nothing but sand. This is all alive but stands only about four or five inches high.

Both pieces are now in full bloom. I have a little of the clover in my yard in the city that measures eighteen inches. This of course has had plenty of water and got a good start in the fall. It is on the south side of the porch where it received the drippings from the eaves and a good share of the time during the winter was covered with ice. I am going to sow more of this clover in August as I think in favorable locations it will do well in this climate.

R. Morrill, Benton Harbor, Berrien Co., May 20:

It was so dry in August and September last that I did not sow the two bushels of Crimson clover seed I purchased but have it yet on hand hoping to try it this fall. All those who sowed late here lost it, but I know of two small lots sown early on damp land that now make a fair showing, eight to ten inches high and beginning to blossom.

E. F. Garland, Berrien Springs, Berrien Berrien Co., May 20:

I sowed two acres to Crimson clover on dry gravelly soil, using about 28 pounds of seed. It was sown late, as the weather was very dry. It wintered all right, as good as any clover, and is now in bloom and makes a good show.

Geo. W. Grant, Coloma, Berrien Co., May 23:

There was some Crimson clover sown here last fall. I have talked with several who have it and they say that it does not stand the winter well. Where it is not winter-killed it stands 8 to 10 inches high. I hardly think it will be a success sown in the fall, but I have not seen enough of it to pass a decided opinion.

H. M. Marion, Coloma, Berrien Co., May 24:

In reply to your inquiry I would say that I purchased last year five bushels of Crimson clover seed of A. N. Brown, Wyoming, Delaware. Four bushels were sold to others. One bushel I sowed in four acres of orchard on soil which varied from clay to sand, with a blue clay subsoil. The land was well drained at a depth of three feet. The soil, except one poor spot, was in fair condition. The clover was sown September 5 and came on very unevenly on account of the drouth which was general with us last fall. Over the drains however it came up at once. This spring it was in all stages of growth, from small plants just coming up to large vigorous plants having roots four to seven inches long. On the poor ground the clover has not made anything of a stand, but over most of the field the plants are now six to ten inches high and in blossom. The roots of these flowering plants are all covered with nodules, showing the value of this plant as a nitrogen trap. Most of those to whom I sold seed will try it again. I shall try again but shall fertilize the land with muriate of potash and acid phosphate.

L. W. Ruth, Benton Harbor, Berrien Co., June 21:

On September 7, 1894, I sowed Crimson clover seed, one peck on three-fourths of an acre—also one and one-fourth bushels of oats designed as a mulch to protect the crop during winter and spring. The ground had produced a crop of melons. The vines were removed and a good seed bed prepared with spring tooth and smoothing harrows. As the soil was in good condition and the weather favorable, the seed came up in three days and grew nicely. The clover made a satisfactory growth in the fall and came through the winter all right, but failed to meet my expectations in the spring. There was considerable cold weather during April and part of May, and it was very dry. The ground was hard, not having been plowed, and for weeks the clover simply existed —did not grow. It blossomed when about ten inches high, when it was turned under. Another piece, sown September 20, the ground prepared in the same way and in good condition, but no rain immediately following, made a feeble growth in the fall and was heaved out by the freezing and thawing in the spring. While Crimson clover has not entirely met my expectations, I shall try it again, as it will be a boon to the fruit grow-growers if it can be produced succesfully. If we had had the usual amount of rain last spring I think the first sown patch would have been all that could have been desired.

I shall sow again this fall, from the first to the middle of August, in corn, sowing eight quarts per acre. Where it can be done, land should be plowed, otherwise it will be too hard to insure a satisfactory growth in the spring. My chief ambition is to get a good well matted growth in the fall, and this I hope to secure by early and reasonably thick sowing. I shall not sow oats again as their luxuriant growth during the late warm fall I think interferes with the growth of the clover.

John H. Lee, Benton Harbor, Berrien Co., June 24:

About September 1, 1893, I sowed about one bushel of the best Delaware Crimson clover seed in my young peach orchard of ten acres. It made a good crop and was turned under the second week in May, 1894. I left strips about one foot wide in the center between the trees. These strips of clover ripened seed about June 1, and were cultivated over the second week in June, so that the seed was well distributed throughout the orchard. In this orchard I found a fine stand of clover in the fall of 1894, which survived the winter and would probably have made a heavy crop to turn under except for the dry weather in April which greatly retarded its development. As it was, I had a good stand about one foot high which was turned under the second week in May.

In 1894 each head of clover matured a heavy crop of seed. This year (1895) the heads did not develop well and produced little or no seed, owing I think to the drouth.

I was so well pleased with my success in 1894 that last fall I sent to Delaware and purchased 75 or 80 bushels of the seed and distributed it throughout this vicinity. It was generally sown too late in the season, mostly after September 15, and some as late as the first of October. The little that was sown early did well, as far as I can learn. I sowed it in four acres of tomatoes and about eight acres of corn, finishing about September 1. Most of this did well, stood the winter except on very exposed places, and produced a short, stunted crop, as already stated, owing to the drouth in April. I also sowed some in an old peach orchard of twelve acres, in a vineyard of six acres, besides ten acres sown for seed. This was all sown after September 15, and but little survived the winter, and that little made a very poor show this spring and amounted to nothing. I have concluded from my trial of Crimson clover that under ordinary circumstances it will stand the winters on our lake shore and be a very valuable plant to turn under in our orchards—also for early forage. It thrives best on good land and is extremely responsive to a little fertilizer, especially lime and potash. It seems to delight in a sandy soil. In seasons of frequent showers I think its growth will nearly equal that of medium red clover. I shall sow it this season in corn, potatoes, tomatoes and orchards, as near the middle of August as possible.

Charles H. Hilton, Benton Harbor, Berrien Co., June 25:

I have grown Crimson clover the past two seasons and think very highly of it, both as a fertilizer and as a forage crop. The clover passed last winter in good shape, being killed out very slightly only in very open ground which the high winds had blown bare. But the crop suffered severely on account of the continued freezing and thawing in the late spring, and was also stunted by the excessive dryness of this season, so that the top growth did not amount to as much as it did in the previous year, when in the middle of May we turned down a crop of clover which stood from one foot to twenty inches high. This difference in height was caused by a difference in the quality of the land, the larger growth being on land a trifle lower than the rest and somewhat heavier.

In watching the growth of this crop the past spring I noticed that it was a great feeder on both potash and phosphoric acid, the best growth being made on land which had received a good supply of unleached wood ashes and pure bone meal. I also noticed that although the stalk growth was not as great as in the previous year, the root growth was quite as good, the great quantity of fibrous roots being well covered with the tiny nitrogen sacks, if that expression may be used.

We sent to Delaware for our seed both seasons. The first year, 1893, we sowed half a bushel of seed in one and one-half acres of Cuthbert raspberries. The next year we sowed two bushels on about seven acres. Much of the seed was wasted by being sown too thickly, pieces sown with fourteen pounds to the acre being as good as others receiving more than double that amount of seed. Our soil is sand, mixed with very fine gravel, making the land very porous. We are located two and one-half miles due south and half a mile east of the city of Benton Harbor, on the bluff of the St. Joseph river.

I believe that Crimson clover will do best in an orchard, where the young clover plants will be able to mulch themselves with the leaves that fall from the trees, or in some other place where the crop will receive a thorough mulching. I intend to sow all my raspberry and blackberry patches to clover this August also my peach and pear orchards. In my opinion Crimson clover settles the fertilizer question as far as nitrogen is concerned.

A. C. Glidden, Paw Paw, Van Buren Co., May 16:

There was no Crimson clover sown here last fall but a good deal of experimenting with it is being done this spring. My opinion is that the seedsmen are the only ones

that will benefit by it. We would all be glad to get an adequate substitute for June clover, for both our fall and spring seedings are gone again, the former by spring freezing and the latter by the dry spell in April after it had come up.

David Woodman, Paw Paw, Van Buren Co., May 23:

In reply to your inquiry about Crimson clover I will say that I experimented with it in a small way, one object being to secure a good sample to put with my collection of grasses. I tried it on good strong land well prepared, also on sandy loam, and in neither case did it meet my expectation or satisfy me of its success as a forage plant. It is not a strong branching grower. It matures early, remains in blossom a few days and is gone. There is none of it growing in this immediate vicinity, though O. P. Morton of Texas, Kalamazoo Co., told me he should sow quite a field of it this spring. [Mr. Woodman states that this Crimson clover grown by him was sown in the spring.]

J. J. Woodman, Paw Paw, Van Buren Co., May 21:

Yours of the 18th received and noted. I did bring a small quantity of Crimson clover seed from France in 1878 and sowed it with Medium clover in oats in the spring of 1879. It came up, grew much larger than the Medium clover, blossomed out most beautifully, and all died the following winter. I had not then learned that it was an annual.

D. E. Histed, South Haven, Van Buren Co., May 20:

We sowed forty pounds of Crimson clover seed in four locations; first in corn, second in corn and a young peach orchard, third in a peach orchard and fourth in the open ground. In three of the locations the soil was a sandy loam, in the other a clay loam. The sowing was done about Aug. 15, but on account of dry weather it did not come up at once and some of it never came. That sowed in corn came the best. In all the pieces the plants which got the best start wintered well, while those which were late in sprouting did not make growth enough to prevent the cold from heaving them out of the ground. There is little difference to note in the condition of the clover in the various locations. On the sandy soil it is now in full bloom and on the clay partly so. I think there was not sufficient seed sown and the long drouth was unfavorable. Still after the experience of a partial failure I am sufficiently pleased with Crimson clover to give it another trial.

A. C. Woodruff, South Haven, Van Buren Co., May 20:

I sowed half a bushel of seed on level, sandy soil of only medium fertility. It was mostly killed out, though in spots, even where not protected in any way there is now a pretty good stand. Some of it is now in blossom though of short growth, much less rank than common red clover, new seeding, on similar soil not ten feet away.

M. H. Bixby, South Haven, Van Buren Co., June 13:

We sowed about 15 pounds of Crimson clover seed to the acre in a peach orchard on sandy soil. The clover passed the winter very well but seemed to suffer from the dry weather and March freezing. We expect to give it another trial this year.

J. F. Taylor, Douglas, Allegan Co., May 23:

I sowed half a bushel of Crimson clover seed last September, some of it on a sandy soil, some on a gravelly loam, part being in rye and part in an orchard. The principal drawback seems to have been the dry ground at the time of sowing. Where there was moisture enough to germinate the seed I have a good stand. I do not think the winter injured it. Some shade at the time of sowing seems desirable; hence were there is moisture it comes up nicely among trees. I think it will do well sown among corn in August. The growth of mine is about ten inches on light soil. It began to blossom about ten days ago. We are now plowing it under. I think it is worth further trial.

C. F. Church, Elgin, Ottawa Co., May 20:

My plot of Crimson clover was raked in with a garden rake on Sept. 5, upon sandy loam in excellent tilth into which had been harrowed three bushels of hen droppings and three bushels of unleached ashes. The plot contains one-thirtieth of an acre and one and one-fourth pounds of seed were sown. It came up quickly, grew well, and when the ground froze a light dressing of stable manure was given. The clover was covered by a snow drift from the middle of January until the first of March when a portion of the plot was laid bare. Upon that portion the clover was all killed during March. The rest came through apparently all right, but has failed to grow and utterly failed to stool out. The tallest plant I could find I have just pulled up. It has four stems

varying from nine to twelve inches in height, the root being four and one-half inches long. The land is not naturally very fertile but has a good color and was never cropped until two years ago. I thought it nearly as good land as any on my farm.

Wm. Swingle, Shelby, Oceana Co., May 20:

I obtained from E. G. Packard of Delaware last year sufficient seed to sow one acre which I sowed in three lots on sandy soil ranging in character from quite light to good loam. The land has a western slope. The seed was sown the 15th to 18th of September and came up readily but made only a small growth during the fall. Where it could be seen it was green during the winter but during March it was all killed except where the snow drifted upon it to a depth of two feet or more; there I have a good stand but it is making a very feeble growth, heading out at only four to six inches high. Take it all in all I must say that with me it is not only a disappointment but a failure. I would like to hear from those that have sown it early in the season.

W. H. C. Mitchell, Traverse City, Grand Traverse Co., May 20:

My Crimson clover was a failure last year but I did not expect any other result. I only learned of it late and did not sow until October. It came up and looked finely, but owing to a cold fall and an early winter here it made no growth. We had a very hard winter on seeding. My soil is gravel, sand and loam and produces corn and potatoes finely. I will try Crimson clover again this year.

C. B. Chatfield, Bay City, Bay Co., May 18:

I did not really give the Crimson clover a fair test. I sowed perhaps one-fourth of an acre in standing corn about July 25 on a piece of clay land and black loam mixed. I raked it in with a garden rake and most of it germinated, but the very dry weather of August and the first part of September was a severe test. After I cut the corn I could see a little of it here and there but this spring it was all gone. I intend this year to rake in a little patch in a young orchard I have which is sown to oats; will also try to sow a little corner a few feet square without growing anything else with it and shall be pleased to report what comes of it. A friend of mine sowed a little patch among some corn but reports that the dry weather killed it completely.

Mrs. M. C. Hawley, Chesaning, Saginaw Co., May 31:

The Crimson clover you wished to know about was sown in September after the first rains that broke the drouth. The soil was a black loam with clay subsoil, the surface sloping toward the south. The land had formerly been in oats and had been well manured for four years. The clover was dragged in with a slight sprinkling of rye; it came up slowly and made but little growth before winter set in. It was alive until March when the freezing and thawing killed it all except a few plants at the edge of the field. I was not discouraged however and on the first of May replowed and reseeded, at the suggestion of the Rural New Yorker, and will try to raise more seed next year. I have also sown some on new land with oats. Common red clover has been almost a failure in this vicinity the last two years, caused by what they call the clover root worm. I shall continue experimenting with the Crimson clover until positive that it is going to be a total failure for this part of the state.

Melvin E. Chandler, Greenville, Montcalm Co., May 4:

I bought four pounds of Crimson clover seed of Mr. E. G. Packard of Dover, Delaware, last June and sowed part of it the 23d of June on about two square rods of gravelly soil that had been a hog yard the year before. We had a shower the night after it was sown and it came up in three days. From that time until September it was so dry that the clover simply lived and the "pusley" and pigweeds made it hard work to do that. When the fall rains came the clover commenced to grow and there were one or two blossom heads when the ground froze. It seemed to have wintered all right in March when the snow melted off; then it froze up hard, after which more snow came and when this went off it still seemed all right, but by the 15th of April the most of it was dead. What is left is growing, but is not as far advanced as common clover. On Sept. 8 I sowed half of what seed I had left on heavy ground with rye that I intended to plow under. It came up nicely and looked all right in the early spring but is now dead. There was very little snow on it all winter and most of the time none at all. On Sept. 20 I sowed the remaining seed on some sandy ground, also with rye. The clover grew faster here than on the clay and went into winter in better shape. This piece was covered with snow the entire winter and is now alive and growing, though suffering for want of rain.

S. S. Bailey, East Paris, Kent Co., May 17:

I sowed last fall, Sept. 8 to 11, several patches of Crimson clover with seed from A. N. Brown, Wyoming, Delaware. A part was in a peach orchard on both sand and clay, the seed being dragged in on ground that had had no previous preparation. I also sowed some on a piece of low ground which had been seeded to red clover in the spring but which had made a poor catch. This was also dragged in, though the dragging did not show much, the ground being dry and hard. Considerable Crimson clover now shows among the other clover and will help materially where the common clover was thin. In the peach orchard where it got a good catch the Crimson clover is now about one foot high and has been in blossom about ten days—a very pretty sight too. This is on light sandy land facing the south. I think this clover passed the winter as well as common clover; can see no difference. On heavy clay it did not get sufficient hold to stand heaving, but I think common clover sown at the same time would have shown the same result. Such has been my experience on heavy clay. I believe that on sandy lands, especially those in the northern part of the state which are usually covered with snow till late in spring, this clover, sown early enough to get a good start in the fall, will be of great value.

W. P. Nellist, Ada, Kent Co., May 18:

The twenty pounds of Crimson clover seed I purchased of Mr. Bancroft was sown during the last days of August in about two acres of corn, but on account of drouth it did not come up until October. The land is rolling and sandy. The clover made a fair growth and went into the winter looking fairly well. It winter-killed in exposed places but where the snow remained on it came through all right and is now in blossom. I shall plow under what I have and try it again this fall.

L. G. Townsend, Ionia, Ionia Co., April 10:

We put in about six acres of land to Crimson clover last year. We sowed about the last of August. Have not the exact date at hand but it was just after our first good rain. It came up and made a good stand—grew a long root, and while we thought we were a little late in getting it in we were well satisfied with its appearance when cold weather set in. The land is a sandy loam with a very little low land next to a small "cat hole" or swamp in the center. This low land is about all there is of it this spring. All the rest seems dead. As we have left about enough seed to sow this piece again we will put it into spring rye for pasture and plow it under in July or the first of August and sow again to the scarlet clover.

Agricultural College, Ingham Co.:

On the College farm last year four plots of about one-fourth acre each were sown at successive dates during September, the first sowing being on September 4, immediately after the first fall rain. This plot was sown on a sandy hillside sloping to the south and extended down on a piece of bottom land of heavy soil. The plants started well and made a growth of about two inches by winter. When the snow disappeared, the last of February, the clover was green and apparently uninjured on the sandy hillside but all dead on the flat. During March that upon the hillside also disappeared, save a few feeble plants. The next plot was sown September 7 in standing corn on a level piece of very light sand which had borne its first crop the year previous. It consisted of a strip two rods wide on the west side of a field and was protected on the west by a grove of timber and by a rail fence. These obstructions caused the snow to lie in drifts upon the clover nearly all winter and well into the spring. When the drifts disappeared late in March the clover was in good condition, and with the exception of one wet spot and a few scattering plants in exposed places it came forward and made a satisfactory growth. It did not grow as large however as a field of red clover adjoining but came on much earlier, a few blossom heads appearing as early as the 10th of May. It was cut for seed, fully ripe, June 28.

On September 18 the last sowings were made, one plot on rolling land, mostly sand, the other on level, loamy upland. These plots made but little growth in the autumn and when the snow disappeared in the spring all the plants were dead. In the botanical garden two small plots were sown, one early in the summer, the other in September. The first planting made a very thick, vigorous growth and showed a few blossoms when snow came. When the snow disappeared in the spring these plants contained a little life but were soon afterward all dead. The small plants, sown late, came through all right. The location was a protected valley and the soil a black sand, moist but well drained, and heavily fertilized. The following clovers sown at the same time as the first of these plots of Crimson clover and growing close by on the same kind of soil had

also made a vigorous growth the previous autumn, none of them however quite equal to the Crimson clover: Red clover, Alsike clover, White clover and Black medic (*Medicago lupulina*). All these passed the winter uninjured.

The following reports from several counties in this State are slightly condensed from the files of the Rural New Yorker for April and May of this year:

Berrien:

Crimson clover sown in or before the first week in September generally made a good stand and went into the winter promising well. In exposed places the March weather froze it out; generally it passed through the severe winter fairly well and was green in the spring. But owing to the extremely dry spring it has made very little growth and at this writing, May 13, is only about six inches high, and the heads are not much larger than beans. I intend to leave a part sown in corn stubble and see what it will amount to by June 10. Where it was sown in rich ground it made the best stand and stood the winter best. In a young peach orchard, liberally fertilized with bone meal and potash about the trees, the stand of the clover showed very distinctly where the fertilizer was sown.

Van Buren:

I sowed a field of tomatoes with Crimson clover the last of September. On account of the vines there could be no preparation of the soil and of course much seed was lost. Still, considerable germinated and is now (May 13) growing finely, six to ten inches high. It did not winter-kill. The land is a heavy clay loam and the small plants did not heave out. I shall seed another piece this fall.

Van Buren:

I sowed four acres of orchard September 5. The plants are very uneven in size and in patches it has not yet come up. In the low places where snow covered the ground it seemed to do the best. From my experience so far I am not discouraged. I shall sow it again next fall but will use potash and bone dust. Those plants which had a good start in the fall did well.

Allegan:

Sowed September 26 in both apple and peach orchards. It made very little growth in the fall owing to the dry weather. The winter was favorable, as we had plenty of snow. While I cannot say that it is a success here I have a fairly good stand in places.

Ottawa:

On September 5, I sowed one and one-quarter pounds of seed on about five square rods of sandy loam about ten miles west of Grand Rapids. It came through the winter all right until March 1, soon after which a thaw took the snow off from an elevated part of the plot. About March 15 cold weather, two degrees below zero, killed all the clover on this part; the rest came on all right.

Grand Traverse:

I sowed one peck of seed, part on sandy soil, part on clay. That on the light soil seemed to do best. On the clay it came up all right but made less growth and an occasional plant winter-killed. I see no reason why there should not be a crop. I had three acres of medium clover near by on heavy soil which appears to be nearly all killed.

SUMMARY AND SUGGESTIONS.

It will be noticed that only one or two of the above trials was entirely successful. Still, some of the others came so near being satisfactory that many persons will be inclined to give this clover further trial. The question therefore arises do these tests indicate the probable result of future efforts to grow Crimson clover in this state? Reports from forty growers in seventeen counties are perhaps not as many as could be desired for a basis of an opinion; still they have considerable value. The past winter,

on the whole, must be considered to have been favorable for this crop. The ground was bare of snow over much of the lower peninsula longer than usual during the first half of the winter, but there was not the ordinary amount of alternate freezing and thawing, while during the latter part of winter there was a continual covering of snow over most of the state. March was of about its usual character. Wheat wintered well considering its generally poor condition in the fall. Many of the sowings of Crimson clover appeared to pass the winter successfully only to be killed by the freezing and thawing of early spring. Still I do not see how better results can be expected under ordinary circumstances in the future. Soil, exposure, and location in the state had, as they must always have, their influence on the result. The western and northern counties were favored this year as usual, with a heavier and more permanent covering of snow than other sections of the state. On sandy soil and rolling land the clover did the best, except where the soil was too dry or where the snow blew off. There was in some instances a failure to get a good stand owing to dry weather, and in many cases the growth when winter set in was less than was desireable. Late summer drouths are to be expected over much of this state, which must in the future often prevent as successful summer and autumn seeding as can be secured in some other parts of the country. Last autumn, however, was unusually dry and therefore a better growth before winter may generally be expected than was obtained last season.

Much has been written on the preparation of the land for this crop to insure its safely passing the winter. In England where this clover is grown with some difficulty it is said to winter-kill if sown on newly plowed land but to pass the winter uninjured if merely harrowed in on stubble. The source of the seed is also supposed to affect the hardiness of this clover, but I know of no experiment to show how much this effect may be. American seed is generally considered the best for this country and was used in nearly all of the trials above recorded. Foreign seed is cheaper and is sold by some of our seedsmen.

Crimson clover is apparently less hardy than common red clover, though there appears a difference of opinion on this point. Its success or failure however does not rest on that fact alone. Red clover is sown in the spring over most of this state, and has time to become well established before winter, while Crimson clover to succeed must be sown in the fall or summer. A moderate development in autumn, probably two to three inches in most localities, seems most favorable to its passing the winter, though a smaller growth will winter safely where covered with snow. Plants, however, which are small in the fall do not attain a full development in our climate but run rapidly to seed in the spring with a single or but few stalks. Judging mainly from the experience of the past season, it seems probable that over most of the lower peninsula of Michigan, Crimson clover will not prove to be a satisfactory crop though for certain locations, particularly along the western part of the state, it seems worthy of further trial. Under ordinary circumstances a smaller growth is to be expected here than in warmer climates.

CLOVER SOWN EVERY MONTH IN THE YEAR.

In March, 1894, twelve plots, each one rod wide by eight rods long, were laid off to be sown to common red clover, one plot each succeeding month. At the same time an equal number of packages of seed were prepared, one for each plot, weighed out at the rate of twelve pounds per acre. Six of the plots, which were not to be seeded until after the growing season, were in June sown to German millet, each of the remaining plots being kept clean by cultivation until the clover seed was sown. The seeding was done in each case during the last ten days of the month. On the plots sown from March to October inclusive the seed was covered by a harrow or a fine toothed cultivator; during the four remaining months, in which the soil was more or less frozen, the seed was left without covering.

Following are notes taken at time of sowing and at successive periods of growth:

Month.	Notes at seeding time.	Condition November 6, 1894.	Condition April 30, 1895.
March	Soil dry.	Stand good; too thick in a few places.	Wintered without injury.
April	Rather wet.	Nearly as good a growth and stand as the March plot.	Practically equal to the March plot; one thin spot.
May	Somewhat dry.	A uniform but thin stand. Plants vigorous.	Rather thin and weedy. About half a full stand.
June	Dry and hot. Soil lumpy.	A small area thinly set with large vigorous plants. Most of the plot bare, save for scattering plants which have come up since the fall rains.	Plot all bare except a few good plants in one locality.
July	Sown after a light rain.	A rather thin stand of plants which have come up since the fall rains.	Nearly bare. The poorest plot of all. Contains a few stunted plants which seem to have come up this spring. Some small plants of timothy.
August	Very dry.	A good stand of plants which are of the same size or a little larger than on the July plot, having two or three rough leaves.	A very few feeble plants which have wintered over, and now and then one which has come up this spring. Plot conspicuous for about half a stand of vigorous timothy plants from volunteer seed.
September	Cultivated in on millet stubble.	A very thick stand of plants still in the seed leaf.	Scattering plants, all of which have started this spring. Also a good sprinkling of small volunteer timothy.
October	Cultivated in on millet stubble.	No plants above the surface, but the seed well sprouted and nearly up.	Clover about the same as on the September plot—less than one-fourth of a stand.
November	Bare frozen ground.		About equal to the October plot but more spotted. The seed coming up chiefly in sheltered places along the millet stubble.
December	Bare frozen ground.		A good stand.
January	About two inches of snow.		A poor stand, the few plants coming mainly from cracks in the soil.
February	Surface mud, but frozen beneath.		A good stand, equal to that of December, but plants more confined to the cracks in the soil.

It will be noticed that the only months which gave a good seeding were February, March, April and December. A gradual falling off appears in the stand obtained from March to June, 1894, though the April sowing did nearly as well as that of March. Rain was abundant in April and the most of May of that year. All the clover which started before July made strong, vigorous plants which wintered safely. The July seeding failed to come up until the fall rains began and its plants, together with those from the August, September and October seedings were too small to pass the winter. Why the January seeding nearly failed and that of December was so successful does not appear. The results on the whole support the general practice in this locality of sowing clover seed in late winter or early spring.

THE COMMON NAMES OF THE CLOVERS.

The name "clover" properly applies to the genus *Trifolium*, but in popular use it has been given to a wide variety of plants. The following list contains most of the common names in the English, German and French languages which are applied to plants sometimes or generally called clovers. The names from the German and French are generally translated. The list is arranged alphabetically by the common names, all those pertaining to a given species being also brought together under the name most used, or which is here adopted as the standard. See, for example, "Alfalfa." A supplemental list is given arranged by genera and species. In preparing these lists I have received valuable assistance from my colleague, Prof. C. F. Wheeler.

ALEXANDRINE CLOVER. *Trifolium Alexandrinum.* See Egyptian Clover.

ALFALFA. *Medicago sativa.* Lucerne; French Lucerne; French Clover, in part; Mexican Clover, in part; Lucerne Clover; Lucerne Medicago; Alfalfa Clover; Chilian Clover; Brazilian Clover; Styrian Clover? Sainfoin, erroneously; Spanish Trefoil; Purple Medick; Manured Medick; Cultivated Medicago; Medick. *Persian,* Isfist; *Greek,* Medicai; *Latin,* Medica, Herba Medica; *Italian,* Herba Spagna; *Spanish,* Melga or Meilga, also (from the Arabic), Alfafa, Alfasafat, Alfalfa; *French,* La Lucerne; *German,* Lucerne, Common Fodder Snail Clover, Blue Snail Clover, Branching Clover, Stem Clover, Monthly Clover, Horned Clover in part, Perennial Clover, Blue Perennial Clover, Burgundy Clover, Welsh Clover in part, Sicilian Clover.

The name Alfalfa, by which this species is now generally known in the United States, came into use in 1853 at the time this forage plant was introduced into California from Chili, where it had been grown under this Spanish name. Previous to that time Alfalfa was but little grown in this country and was generally known under its French name, Lucerne.

ALFILARIA. *Erodium cicutarium.* Storksbill; Pin Clover; Pin Grass; Pin Weed; Filaria; Filaree. Its Spanish name *Alfilerilla,* from which most of its common English names are derived, signifies a pin.

ALPINE CLOVER. *Trifolium alpinum.*

ALSACE CLOVER. *Trifolium hybridum.* Probably a corruption of "Alsike Clover" which see.

ALSIKE CLOVER. *Trifolium hybridum.* Swedish Clover; White Swedish Clover; Giant White Clover; Hybrid Clover; Perennial Hybrid Clover; Bastard Clover; Elegant Clover. The name Alsike is derived from a parish and village of that name in Sweden, where this species was cultivated at an early day.

ALSYKE CLOVER. *Trifolium hybridum.* A rare spelling. See Alsike Clover.

ARABIAN SNAIL CLOVER. *Medicago maculata.* A German name. See Spotted Medick.

ASPERSET. *Onobrychis sativa.* See Sainfoin.

BALSAM CLOVER. *Melilotus cœruleus.* Blue Stone Clover; Honey Clover; Blue Honey Clover; Bee Clover; Cheese Clover; Schabzieger Clover; Sweet Trefoil, Sevenseed, Musk Clover, Blue Melilot Trefoil—all German names.

BARBARY BUTTONS. *Medicago scutellata.* See Snails.

BASTARD CLOVER. *Trifolium hybridum.* See Alsike Clover.

BASTARD LUPINE. *Trifolium Lupinaster.*

BASTARD LUZERNE. *Medicago media.* See Sand Luzerne.

BASTARD POD CLOVER. *Trifolium hybridum.* See Alsike Clover.

BEE CLOVER. *Melilotus cœruleus* and *Trifolium repens.* See Balsam Clover and White Clover.

BERSIN CLOVER. *Trifolium Alexandrinum.* See Egyptian Clover.

BIRD'S FOOT. *Ornithopus sativus.* See Serradella.

BIRD'S FOOT CLOVER. See Bird's Foot Trefoil.

BIRD'S FOOT TREFOIL. The genus *Lotus*, especially *Lotus corniculatus;* Yellow Trefoil; Sweet Trefoil; Horned Clover; Cat-in-Clover; *Fr.* Lotier; *Ger.*, Common Horn Clover, Horned Pod Clover and Umbelled Clover.

BITUMINOUS CLOVER. *Psoralea bituminosa.* Treacle Clover; Garden Clover.

BLACK MEDICK. 1. *Medicago lupulina.* In Great Britain: Hop Clover in part, Yellow Clover in part, Nonsuch, Black Nonsuch, Black Grass, Shamrock (by substitution. See White Clover.) In France: Lupuline, Minette, Minette Dorée, Little Field Melilot and Yellow Luzerne. In Germany: Hop Snail Clover, Little Yellow Snail Clover, Wolf Clover, Little Bristly Clover, and frequently but erroneously, Hop Clover. 2. (Erroneously) *Medicago maculata.* (New Zealand Ag. Rep., 1894.) See spotted Medick and Black Nonsuch.

BLACK NONSUCH. *Trifolium procumbens.* This is the Black Nonsuch of the Norfolk farmers (Loudon, 1831). Miller (1884) calls *Medicago lupulina* Black Nonsuch. See Hop Clover and Nonsuch.

BLADDER CLOVER. *Trifolium fragiferum.* See Strawberry Clover.

BLADDER-PODDED CLOVER. *Trifolium spumosum.*

BLOOD CLOVER. *Trifolium incarnatum.* A German name. See Crimson Clover.

BLUE HONEY CLOVER. *Melilotus cœruleus.* See Balsam Clover.

BLUE MELILOT TREFOIL. *Melilotus cœruleus.* See Balsam Clover.

BLUE PERENNIAL CLOVER. *Medicago sativa.* See Alfalfa.

BLUE STONE CLOVER. *Melilotus cœruleus.* See Balsam Clover.

BOCCONE'S CLOVER. *Trifolium Bocconi.*

BOKHARA CLOVER. *Melilotus alba.* A name frequently applied to this species from its being largely exported from the khanate and city of

Bokhara, in central Asia. There are several variations in the spelling of this name. See Sweet Clover. Compare White Bokhara Clover.

BOURGOYNE. *Onobrychis sativa.* A name sometimes applied to this species in France. See Sainfoin.

BRABANT CLOVER. *Trifolium pratense.* (Brabant now forms a part of Belgium.) See Red Clover.

BRANCHING CLOVER. *Medicago sativa.* A German name. See Alfalfa.

BRAZILIAN CLOVER. *Medicago sativa.* One of the names applied to this species upon its introduction into California from South America. See Alfalfa.

BREAST CLOVER. *Anthyllis Vulneraria.* See Wound-wort.

BRISTLY-HAIRED SNAIL CLOVER. *Medicago hispida.*

BRISTLY HEAD. *Onobrychis sativa.* A German name. See Sainfoin.

BROAD CLOVER. See Broad-Leaved Clover.

BROAD-LEAVED CLOVER. *Trifolium pratense.* The prevailing name in England for this species under cultivation. See Red Clover.

BROWN CLOVER, 1. *Trifolium badium*, Schreb. The ordinary name for this species in England. Called in Germany Chestnut-Brown Clover. 2. Applied in France to *Trifolium procumbens.* See Hop Clover.

BUFFALO CLOVER. 1. *Trifolium reflexum.* Properly so called. 2. *Trifolium stoloniferum.* (Eaton & Wright; N. Am. Bot., 1840.) More often and properly called Running Buffalo Clover, which see. 3. *Astragalus caryocarpus.* So called in South Dakota. (C. F. Wheeler.)

BURR CLOVER. *Medicago denticulata.* The usual name for this species in California, where it is now quite extensively grown; Medick Clover; Medic Burr; Toothed Medick. 2. *Medicago maculata.* Erroneously so called in the Southern States from its resemblance to the above species. See Spotted Medick.

BURGUNDY CLOVER. *Medicago sativa.* A German name. See Alfalfa.

BUSH CLOVER. 1. *Lespedeza striata.* (Flint, Grasses and Forage Plants, 1888.) See Japan Clover. 2. *Lespedeza frutescens.* (Exp. Station Hand-Book, 1893.) 3. An American name for *Lespedeza.* (Lindley & Moore, Treasury of Botany.) 4. The genus *Hedysarum* [and *Lespedeza*] (Eaton & Wright, N. Am. Bot., 1840.)

CABUL CLOVER. *Melilotus alba.* See Sweet Clover.

CALIFORNIA CLOVER. *Medicago maculata.* This name, which is used in the Southern States, is a misnomer, as the plant is seldom grown in California, though a species closely resembling it (M. *denticulata*,) is well known there. See Spotted Medick.

CALVARY CLOVER. See Clover of Calvary.

CANADA BUSH CLOVER. *Hedysarum Canadense.*

CARNATION CLOVER. *Trifolium incarnatum.* A name occasionally applied to this species, chiefly in England. See Crimson Clover.

CAROLINA CLOVER. *Trifolium Carolinianum.*

CASTOR CLOVER. *Menyanthes trifoliata.* See Swamp Clover.

CAT CLOVER. 1. *Anthyllis Vulneraria.* See Wound-wort. 2. *Trifolium arvense.* See Rabbit Foot Clover. Compare Yellow Cat Clover.

CATERPILLARS. *Scorpiurus vermiculatus.*

CHEESE CLOVER. *Medicago cœruleus.* See Balsam Clover.

CHILIAN CLOVER. *Medicago sativa.* So called upon its introduction in 1853 into California from Chili, where it had been extensively cultivated. See Alfalfa.

CLOVER OF CALVARY. *Medicago Echinus.* Herb sanguinalis; Sea-egg Clover. It received its name from its pods, which when uncoiled resemble a crown of thorns.

CLOVER OF ROUSSILLON. *Trifolium incarnatum.* One of its names in France. See Crimson Clover.

CLOVER TREFOIL. *Trifolium medium.* See Mammoth Clover.

CLUSTERED CLOVER. *Trifolium glomeratum.*

COCKSHEAD. *Onobrychis sativa.* An English and German name. See Sainfoin. The Cock's Head of the West Indies, however, is *Desmodium tortuosum.*

COMMON CLOVER. 1. *Trifolium pratense.* See Red Clover. 2. *Trifolium repens* (Miller, Dict. of Eng. Names of Pl.). See White Clover.

COMMON RED CLOVER. *Trifolium pratense.* See Red Clover.

COW CLOVER. Peter Henderson states in his Hand Book of Grasses, 1875, p. 80, that the American grown mammoth clover, known in this country as *Trifolium medium,* was sent to England at an early day as the "Large American or Cow Clover." See Cow Grass.

COW GRASS. Some confusion exists in regard to the use of this name. It appears formerly to have been applied to *Trifolium medium* (Loudon, 1831), or the variety so called, but for the last forty years or more it has nearly always been used in England for the form called *Trifolium pratense perenne.* See Red Clover. Mammoth Clover and Perennial Red Clover.

CREEPING BUSH CLOVER. *Lespedeza repens.*

CREEPING CLOVER. *Trifolium repens.* See White Clover.

CREEPING TREFOIL. *Trifolium repens.* See White Clover.

CRIMSON CLOVER. *Trifolium incarnatum.* Scarlet Clover, German Clover, German Mammoth Clover, Italian Clover, *German,* Inkarnatklee (Incarnate Clover), French Clover in part, Egyptian Clover in part. Blut Klee (Blood Clover) and Fleisch-rother Klee (Flesh Colored Clover). *French,* Trefle de Roussillon, Trefle Incarnat and Farouche. Several varieties differing in vigor, time of maturity and color are known.

CULTIVATED MEDICAGO. *Medicago sativa.* See Alfalfa.

DOG CLOVER. *Melilotus officinalis.* So called in France. See Yellow Sweet Clover.

DUTCH CLOVER. *Trifolium repens.* The usual name for this species in England—so called from being extensively grown in Holland. See White Clover.

EARLY CLOVER. *Trifolium pratense.* See Red Clover.

EGYPTIAN CLOVER. 1. *Trifolium incarnatum.* Occasionally so called in the United States from its seed being imported from Egypt. See Crimson Clover. 2. *Trifolium Alexandrinum.* Known also as Alexandrine and Bersin Clover (Arabia *bersym* or *berzun*). (DeCandolle, Orig. Cult. Pl., p. 107.)

ELEGANT CLOVER. *Trifolium hybridum.* See Alsike Clover. (This species was once known as *Trifolium elegans,* Rehb.)

ENGLISH CLOVER. *Trifolium pratense.* See Red Clover.

ESPARCETTE. *Onobrychis sativa.* See Sainfoin.

ESPARCETTE CLOVER (rare). *Onobrychis sativa.* See Sainfoin.

ESPARSETTE. (German spelling) *Onobrychis sativa.* See Sainfoin.

FAROUCHE. *Trifolium incarnatum.* A name frequently applied to this species in France. See Crimson Clover.

FENUGREEK. *Trigonella fœnum-græcum.* Known in Germany as Buckhorn Clover, Cow Horn, Goat's Horn, Sevenseed (see also Balsam Clover) and Greek Hay. DeCandolle, in his Origin of Cultivated Plants, applies the name Trigonel to this species.

FEVER CLOVER. *Menyanthes trifoliata.* See Swamp Clover.

FIELD CLOVER. *Trifolium arvense.* See Rabbit Foot Clover. Also applied erroneously in Germany to *Medicago lupulina* (see Black Medick) and sometimes to *Trifolium repens* (see White Clover).

FIELD TRIFOLIUM. (Darlington.) *Trifolium arvense.* See Rabbit Foot Clover.

FIR CLOVER. *Anthyllis Vulneraria.* See Wound-wort.

FLESH COLORED CLOVER. *Trifolium incarnatum.* See Crimson Clover.

FLORIDA CLOVER. 1. *Richardsonia scabra.* See Mexican Clover. 2. *Desmodium molle* (*tortuosum*) Beggar Weed. (Fla. Ex. St., B. 8.) See Tick Trefoil.

FODDER CLOVER. *Medicago sativa.* See Alfalfa.

FODDER SNAIL CLOVER. *Medicago sativa.* One of the names now used in Germany. See Alfalfa.

FOX, OR FOX TAIL, CLOVER. *Trifolium rubens.* See Reddish Clover.

FRENCH CLOVER. 1. *Medicago sativa.* See Alfalfa. 2. *Trifolium incarnatum.* See Crimson Clover.

FRENCH HONEYSUCKLE. *Hedysarum coronarium.* 1. Sulla; Spanish Sainfoin; *Sainfoin á boquets*; Soola Clover; Maltese Clover. 2. In Germany, Sainfoin (*Onobrychis sativa*) is sometimes called French Honeysuckle. Compare Honeysuckle.

GARDEN CLOVER. *Psoralea bituminosa.* See Bituminous Clover.

GARDNER'S CLOVER. *Cytisus sessilifolius.*

GERMAN CLOVER. *Trifolium incarnatum.* See Crimson Clover.

GERMAN MAMMOTH CLOVER. *Trifolium incarnatum.* A name now applied to a variety of this species by an American seedsman. See Crimson Clover.

GIANT CLOVER. 1. *Trifolium medium.* See Mammoth Clover. 2. *Melilotus alba.* 3. *M. officinalis.* See Sweet Clover and Yellow Sweet Clover. Compare Siberian Giant Clover and Giant Melilot Clover.

GIANT INCARNAT CLOVER. *Trifolium incarnatum.* A name applied to a variety of this species by an American seedsman. See Crimson Clover.

GIANT MELILOT CLOVER. *Melilotus officinalis.* See Yellow Sweet Clover.

GIANT WHITE CLOVER. *Trifolium hybridum.* (Henderson's Hand Book of Grasses, 1875, p. 94). See Alsike Clover.

GOAT CLOVER. See Reddish Clover, Goats' Rue and Swamp Clover.

GOATS' RUE. *Galega officinalis.* Goat Clover, Spotted Clover.

GOLDEN CLOVER. 1. *Trifolium agrarium.* The usual name for this species in England, where it is also sometimes known as Yellow Meadow Trefoil and Yellow Hop Clover. See Hop Clover. In Germany this species is called Field Clover, Hop Clover, Yellow Hop Clover, Yellow Clover, Gold Colored Clover and Large Golden Clover. 2. In Germany the name Golden Clover is applied also to *Trifolium badium*, (Brown Clover), *T. procumbens* (Hop Clover), and *T. filiforme* (Suckling Clover). See Yellow Clover.

GRAY CLOVER. *Trifolium arvense.* See Rabbit-foot Clover.

GREEN CLOVER.* *Trifolium medium.* A German name. See Mammoth Clover.

GREAT CLOVER. *Trifolium pratense.* A name under which this species was known upon its introduction into England from Flanders. See Red Clover.

HAIR CLOVER. *Trifolium arvense.* A German name. See Rabbit-foot Clover.

HAIRY BUSH CLOVER. *Lespedeza hirta.* (Killebrew.)

HARD CLOVER. *Trifolium arvense.* See Rabbit-foot Clover.

HARD TREFOIL. *Melilotus.* See Stone Clover.

HARDY LUZERNE. (Luzerne Rustique) *Medicago media.* See Sand Luzerne.

HARE'S HEAD. *Onobrychis sativa.* A German name. See Sainfoin.

HARE'S FOOT. *Trifolium arvense.* See Rabbit-foot Clover.

HARE'S FOOT CLOVER. *Trifolium arvense.* See Rabbit-foot Clover.

HARE'S LITTLE PAW. *Trifolium arvense.* See Rabbit-foot Clover.

HART'S CLOVER. *Melilotus officinalis.* (Miller, Dict. of Eng. Names of Plants.) See Yellow Sweet Clover.

HEART CLOVER. 1. *Medicago polymorpha* (Gard. Chron., 1849, p. 411). 2. *Medicago maculata* (Miller, Dict. of Eng. Names of Pl., 1884). See Spotted Medick.

HEMP CLOVER. *Melilotus alba, M. officinalis* and *M. macrorrhizus.* See Sweet Clover, Yellow Sweet Clover and Large Rooted Sweet Clover.

HERB SANGUINALIS. *Medicago Echinus.* So called from a blood-red spot in the center of each leaflet. See Clover of Calvary.

HONEY CLOVER. *Melilotus cœruleus.* See Balsam Clover.

HONEYSUCKLE. See Honeysuckle Clover, French Honeysuckle and West Indian Honeysuckle.

HONEYSUCKLE CLOVER. *Trifolium repens.* See White Clover.

HONEYSUCKLE GRASS. *Trifolium repens* (Philip Miller, 1726). See White Clover. Compare French Honeysuckle.

HOP CLOVER. 1. *Trifolium procumbens.* Though this is "the true hop clover of the botanist, it is not the hop trefoil of the farmer, which belongs to the medics. It gets the name, hop clover, from the peculiar aspect, like a bunch of hops, of the withered head of flowers which remains even until the seed is ripened. This plant was formerly cultivated, but its scanty and innutritious herbage soon brought it into disfavor and caused it to be superseded by *Medicago lupulina* whose leaves are so much like those of the *Trifolium procumbens* as to have caused the transference of the name" (Roland, Management of Grass Land, London, 1881, p. 143). Lindley and Moore say in their Treasury of Botany, 1866: "The hop trefoil of the botanist is *Trifolium procumbens* but the hop trefoil of the farmer is *Medicago lupulina.*" *Trifolium procumbens* is also called Yellow Clover, Shamrock Clover, Brown Clover, Lesser Clover and Low Hop Clover. 2. *Medicago lupulina.* This species is now often called Hop Clover in Germany and apparently by most English farmers as above stated. See Black Medick. 3. *Trifolium agrarium* (Philip Miller, 1726; Am. Agriculturist, 1887, p. 319; Gray's Manual, 1889). See Golden Clover.

HOP TREFOIL. See Hop Clover.

HORNED CLOVER. 1. *Lotus corniculatus.* See Bird's Foot Trefoil. 2. *Medicago sativa.* See Alfalfa.

HORNED POD CLOVER. *Lotus corniculatus.* See Bird's Foot Trefoil.

HORSE CLOVER. *Melilotus alba, officinalis* and *macrorrhizus*. See Sweet Clover, Yellow Sweet Clover and Large Rooted Sweet Clover.

HYBRID CLOVER. *Trifolium hybridum*. This species was erroneously supposed by Linnaeus, by whom it was named, to be a hybrid between Red clover (*Trifolium pratense*) and White clover (*Trifolium repens*). This supposition still prevails to some extent, and the name Hybrid Clover is occasionally applied to it in various countries. See Alsike Clover.

INCARNATE CLOVER. *Trifolium incarnatum*. See Crimson Clover.

IPECAC WEED. *Richardsonia scabra*. (Fla. Ex. Station, B. 8.) See Mexican Clover.

ITALIAN CLOVER. *Trifolium incarnatum*. See Crimson Clover.

JAPAN CLOVER. *Lespedeza striata*. The usual name for this species in the United States. It was first introduced however from China. It is sometimes called Sherman's Clover, as it came into prominence in the South directly after "Sherman's march to the sea," in 1864.

JUNE CLOVER. *Trifolium pratense*. A name often applied to this species in the United States. See Red Clover.

KIDNEY VETCH. *Anthyllis Vulneraria*. See Wound-wort.

KING'S CLOVER. *Melilotus officinalis*. See Yellow Sweet Clover.

KNOTTED CLOVER. *Trifolium striatum*. Soft Knotted Trefoil.

LADY'S FINGER. *Anthyllis Vulneraria*. See Wound-wort.

LAMB CLOVER. *Trifolium repens*. A German name. See White Clover.

LAMB'S TAIL. *Trifolium arvense*. A German name. See Rabbit-foot Clover.

LARGE AMERICAN COW CLOVER. *Trifolium medium*. A name under which seed of this clover was sold in England in the early part of this century. See Mammoth Clover and Cow Clover.

LARGE CLOVER. *Trifolium medium*. See Mammoth Clover.

LARGE ROOTED SWEET CLOVER. *Melilotus macrorrhizus*, Pers. Known in Germany as Common, Officinal, True, Yellow and Large-Rooted Stone Clover; Yellow Melilot Clover; Wonder Clover; Giant Clover; Horse Clover; Tonto Clover; Mothwort; Hemp Clover and Honey Clover. Compare Yellow Sweet Clover.

LARGE WHITE CLOVER. *Melilotus alba*. See Sweet Clover.

LESSER CLOVER. *Trifolium procumbens*. See Hop Clover.

LITTLE FIELD MELILOT. *Medicago lupulina* (Baillon.) See Black Medick.

LITTLE YELLOW HOP CLOVER. *Trifolium filiforme*. See Suckling Clover.

LOW HOP CLOVER. *Trifolium procumbens*. (Gray's Manual, 1889.) More often called Hop Clover, which see.

LUCERN. *Medicago sativa*. The usual spelling in England. See Alfalfa.

LUCERNE. *Medicago sativa*. The French name for this species, derived, it is generally supposed, from the Canton of Luzern, or Lucerne in Switzerland, where this forage plant was largely cultivated at an early day. A. DeCandolle suggests another, and, as he thinks, a more probable origin of the name Lucerne as applied to this species. He says: "The Spaniards had an old name *eruye*, mentioned by Bauhin, and the Catalians call it *userdas*, whence perhaps the patois name in the south of France *laouzerdo*, nearly akin to Luzerne." Luzerne is the usual name

and the usual form of the word now in use for this forage plant in Germany and France. In America this name, generally spelled Lucerne, was formerly in general use, but it has now given place in most localities to "Alfalfa." In France this name Luzerne is also applied in a general sense to other Medicagoes. See Alfalfa.

LUZERNE LUPULINE. *Medicago lupulina.* A French name for this species. See Black Medick.

MALTESE CLOVER. *Hedysarum coronarium.* (Miller, Dict. of Eng. Names of Plants, 1884.)

MAMMOTH CLOVER. *Trifolium medium.* The name most frequently applied to this clover in the United States, where it is also called Large Clover, Tall Clover, Saplin or Sapling Clover and Peavine Clover. It is known in England by the latter name and also as Meadow Clover, Sand Clover, Zigzag Clover, Clover Trefoil, Cow Grass in part, Cow Clover and Large American Cow Clover. In Germany it is called Medium Clover, Early Clover, Wavy-stemmed Clover, Zigzag Hare Clover, Red Perennial Meadow Clover and Soiling Clover (Trogklee). Compare Red Clover and Perennial Red Clover.

MARL GRASS. This name has been applied in England both to *Trifolium pratense* and *T. medium*, the latter application being the most common. Loudon, in 1831, applied the name to *T. medium.* Henderson, in his Hand Book of Grasses (1875) calls "Marle Grass" *Trifolium pratense.*

MAYAD CLOVER. *Trifolium subrotundum.* A species from northern and middle Africa. (Miller, Dict. of English Names of Plants, 1884.)

MEADOW CLOVER. *Trifolium medium.* According to Loudon, in 1831, this was then the best English name for this species. See Mammoth Clover. The name is now often applied in Germany to Red Clover, *T. pratense*, which see.

MEDICK. An ancient classical name for Alfalfa (*M. sativa*), now applied to all the Medicagoes.

MEDICK BURR. *Medicago denticulata.* One of the names applied to this species in New Zealand. See Burr Clover.

MEDICK VETCHLING. *Onobrychis sativa.* A name sometimes used in England. See Sainfoin.

MEDIUM RED CLOVER. *Trifolium pratense.* A name frequently applied to this species in the United States. See Red Clover. In Germany *Trifolium medium* is called Medium Clover. See Mammoth Clover.

MELILOT CLOVER. *Melilotus officinalis* and other species. See Yellow Sweet Clover, and Stone Clover.

MEXICAN CLOVER. 1. *Richardsonia scabra.* A Mexican annual which has become naturalized along the Gulf Coast in the United States, where it is known also as Spanish Clover, Ipecac weed, Florida Clover, Water Parsley, Bellfountain, Poor Toe, Pigeon Weed, etc. 2. *Medicago sativa.* A name sometimes applied to Alfalfa in the southwestern portion of the United States.

MINETTE or MINETTE DORÉE. *Medicago lupulina.* French names for this species. See Black Medick.

MONTHLY CLOVER. *Medicago sativa.* A German name. See Alfalfa.

MOUSE CLOVER. *Trifolium arvense.* One of its German names. See Rabbit-foot Clover.

NONSUCH. 1. *Medicago lupulina.* See Black Medick. 2. "Black Nonsuch" is *Trifolium procumbens.* See Hop Clover.

NATIVE RED CLOVER. *Trifolium pratense.* So called in England. See Red Clover.

NORTHERN CLOVER. *Trifolium medium.* "The Peavine or Northern Clover is a different variety from what is here known as Western Clover, or from the more diminutive Southern variety. It ripens two weeks later than the Western." (Genesee Farmer, 1864.) See Mammoth Clover.

OVAL HEADED CLOVER. *Trifolium alpestre.*

PEAVINE CLOVER. *Trifolium medium.* A name often applied to this species during the past forty or fifty years in the eastern United States and sometimes in England.

PERENNIAL CLOVER. *Medicago sativa.* A German name. See Alfalfa.

PERENNIAL HYBRID CLOVER. *Trifolium hybridum.* See Alsike Clover.

PERENNIAL RED CLOVER. *Trifolium pratense perenne,* Host. This is supposed to be the original wild form of *Trifolium pratense,* reduced to cultivation. By some it is now considered the same specifically as *Trifolium medium.* Lindley and Moore stated in their Treasury of Botany in 1866 that *Trifolium medium* was no longer sold, its place being taken by what was then labeled *Trifolium pratense perenne,* and commonly called Cow Grass.

PIEDMONT CLOVER. *Trifolium pratense.* (France.) See Red Clover.

PIN CLOVER. *Erodium cicutarium.* See Alfilaria.

PLASTER CLOVER. *Melilotus officinalis.* So called becaused used in medicine for plasters or poultices. See Yellow Sweet Clover.

POD CLOVER. *Lotus corniculatus.* See Bird's foot Trefoil.

PRAIRIE CLOVER. "The genus Petalostemon." (Miller, Dict. of Eng. Names of Plants, 1884); "an American name for Petalostemon." (Treasury of Bot., 1866.)

PURPLE CLOVER. *Trifolium pratense.* (DeCandolle.) See Red Clover.

PURPLE BUSH CLOVER. *Lespedeza violacea.* (Killebrew.) See Violet Clover.

PURPLE MEDICK. *Medicago sativa.* See Alfalfa.

RABBIT FOOT CLOVER. *Trifolium arvense.* The usual English name for this species, which occurs in the same or similar form in other languages, as *Fr.* Pied de Lievre, *Span.* Pie de Liebre, *Ger.* Der Hasen Klee (see also Red Hare Clover). Other English names are Hare's Foot Clover, Field Clover, Field Trifolium, Stone Clover in part, Welsh Clover in part. In Germany it is known as Field Clover, Hard Clover, Hair Clover, Hare Clover, Hare's Foot, Hare's Little Paw, Mouse Clover, Cat Clover, Kitten plant or Pussywort, Gray Clover and Lamb's-tail.

RED CLOVER. *Trifolium pratense.* The ordinary name for this species in the United States, where the term also includes *Trifolium medium,* various prefixes being employed to distinguish the two species. Usually where no prefix is given, the name "Red Clover" is understood to mean *T. pratense.* Other names for this species in the United States are Early Clover, June Clover, Small Red Clover, Red Top Clover, and Medium Red Clover. In England it is known as Broad or Broad-leaved Clover, English Clover and Native Red Clover. In Germany it has the names Meadow Clover, Red Meadow Clover, Common Large Clover, Great Clover, Succulent Clover (Wiescherklee), Head Fodder Clover, Welsh Clover, Spanish Clover, Turkish Clover, Brabant Clover. Several of the above

names, together with the names Piedmont Clover, Purple Clover and Red Dutch Clover are also current in France. See Mammoth Clover and Perennial Red Clover.

REDDISH CLOVER. *Trifolium rubens.* Known also in Germany as Red Clover, Fox Clover, Fox-tail Clover, Reddish or Red Goat Clover and Red Hare Clover.

RED DUTCH CLOVER. *Trifolium pratense.* (France.) See Red Clover.

RED HARE CLOVER. *Trifolium rubens.* See Reddish Clover.

RED HEAD CLOVER. *Trifolium pratense.* See Red Clover.

RED TOP CLOVER. *Trifolium pratense.* (Southern Indiana.) See Red Clover.

REVERSED CLOVER. *Trifolium resupinatum.*

RHODE ISLAND CLOVER. *Chrysanthemum Leucanthemum.* A name applied to the Oxeye Daisy in Vermont. (Bot. Gazette, 1894, p. 431.)

RIGID SNAIL CLOVER. (Starrer Schneckenklee.) *Medicago rigidula.*

ROUGH CLOVER. *Trifolium scabrum.*

ROUND-HEADED BUSH CLOVER. *Lespedeza capitata.* (Killebrew.)

ROUND SNAIL CLOVER. *Medicago orbicularis.*

ROUSSILLON CLOVER. *Trifolium incarnatum.* See Crimson Clover.

RUNNING CLOVER. *Trifolium stoloniferum.* (Ex. Station Hand-Book, 1893.) Running Buffalo Clover. (T. & G., Fl. N. Am.; Darlington, Am. Weeds, etc.)

RUNNING BUFFALO CLOVER. *Trifolium stoloniferum.* See Running Clover.

SAINFOIN. *Onobrychis sativa.* The ordinary French name for this species (meaning Saint's Hay or Fodder), the name also being in common use in England and America. Another name frequently applied to it is Esparcette or Asperset, written in French *L'espercet,* in German *Esparzette* and in Spanish *Esparsita.* It is also known in England as Cock's Head, French Grass and Medick Vetchling, in France as Burgoyne, in Italy as Cedrangalo and in Germany as Hare's Head, Bristly Head and French Honeysuckle. Two varieties are known in cultivation, the later and more vigorous being called Double-bearing Sainfoin, or in French *Sainfoin a deux coupes.* DeCandolle states that French growers have often applied the name Sainfoin to Lucerne (*Medicago sativa*) and that this name was in 1882 still applied to that species in the vicinity of Geneva and elsewhere.

ST. MAWE'S CLOVER. *Medicago maculata.* (Miller, Dict. of Eng. Names of Plants, 1884.) See Spotted Medick.

SAND CLOVER. 1. *Trifolium suffocatum.* (Nicholson, Dict. of Gard.) 2. *Anthyllis Vulneraria.* (Thorburn, Seed Cat., 1893.) See Woundwort. 3. *Trifolium medium* (Tr. of Bot.). See Mammoth Clover.

SAND LUZERNE. *Medicago media.* (Haage & Schmidt, Cat., 1894.) Also called Hardy Luzerne. (Vilmorin, Cat., 1894,) and Bastard Luzerne.

SAPLIN CLOVER. See Sapling Clover.

SAPLING CLOVER. *Trifolium medium.* A name often applied to this clover in the United States, particularly in Maryland, Virginia and neighboring states. The "Tall or Saplin" Clover was described by Robt. Sinclair of Baltimore in 1822. See Mammoth Clover.

SCHABZIEGER CLOVER. *Melilotus cœruleus.* A local name in Germany. See Balsam Clover.

SEA-EGG CLOVER. *Trifolium Echinus.* (Miller, Dict. of Eng. Names of Plants.) See Clover of Calvary.

SEASHORE SNAIL CLOVER. *Medicago littoralis.* A German name.

SEA-SIDE CLOVER. *Trifolium maritimum.*

SERRADELLA. *Ornithopus sativus.* Bird's Foot.

SEVENSEED. 1. *Trigonella fœnum-græcum*, Fenugreek. 2. *Melilotus cœruleus*, Balsam Clover.

SHAMROCK. *Trifolium repens.* The national emblem of Ireland, worn in honor of St. Patrick, who is said to have plucked a leaf of this plant to represent the Trinity. By some writers the wood-sorrel, *Oxalis acetosella*, which comes into flower in Ireland about St. Patrick's day, is supposed to have been the original plant used. Frequently *Medicago lupulina* is now substituted for the true shamrock or white clover. See Shamrock Clover.

SHAMROCK CLOVER. *Trifolium procumbens.* (Loudon, Encyclopedia of Agriculture, 1831, p. 872.) See Hop Clover and Shamrock.

SHEEP CLOVER. *Trifolium repens.* A German name. See White Clover.

SHERMAN'S CLOVER. *Lespedeza striata.* See Japan Clover.

SIBERIAN GIANT CLOVER. *Melilotus altissima Sibirica.* White Bokhara Clover. Compare Sweet Clover and Stone Clover.

SICILIAN CLOVER. *Medicago sativa.* See Alfalfa.

SLENDER CLOVER. *Trifolium filiforme.* See Suckling Clover.

SLENDER-STALKED CLOVER. *Trifolium filiforme.* See Suckling Clover.

SMALL-FLOWERED CLOVER. *Trifolium filiforme.* See Suckling Clover.

SMALL RED CLOVER. *Trifolium pratense.* See Red Clover.

SNAIL CLOVER. 1. The Genus Medicago. 2. *Medicago lappacea.* (Haage & Schmidt, Cat. 1894.) 3. *M. scutellata*, Barbary Buttons; "Snails." (Miller, Eng. Names of Plants, 1884.)

SOFT KNOTTED TREFOIL. *Trifolium striatum.* See Knotted Clover.

SOOLA CLOVER. *Hedysarum coronarium.* (Lindley & Moore, Tr. of Bot., 1866; Miller, Dict. of Eng. Names of Pl., 1884.) See French Honeysuckle.

SOUR CLOVER (a German name). *Oxalis Acetosella.* Common Wood Sorrel. Compare Stiff Sour Clover.

SOUTHERN CLOVER. *Trifolium pratense.* A dwarf variety grown in the Southern States about forty years ago. See quotation under Northern Clover.

SPANISH CLOVER. 1. *Richardsonia scabra.* See Mexican Clover. 2. *Medicago sativa.* See Alfalfa. 3. *Trifolium pratense.* (In France, Germany and Switzerland.) See Red Clover.

SPANISH SAINFOIN. *Hedysarum coronarium.* See French Honeysuckle.

SPANISH TREFOIL. *Medicago sativa.* See Alfalfa.

SPOTTED CLOVER. *Galega officinalis.* See Goat's Rue.

SPOTTED MEDICK. *Medicago maculata.* Improperly called Burr Clover, California Clover, and in New Zeeland, Black Medick. Also known as Heart Clover, St. Mawe's Clover, and in Germany, Arabian Snail Clover.

STARRY CLOVER. *Trifolium stellatum.*

STIFF SOUR CLOVER (a German name). *Oxalis stricta, L.*

STONE CLOVER. 1. *Trifolium arvense.* See Rabbit Foot Clover. 2. The genus Melilotus; Hard Trefoil (*Ger.* Lote and Melilot Klee).

3. *Trifolium repens* (Engler & Prantl, 1893). See White Clover. 4. *Medicago falcata.* See Yellow Luzerne.

STRAWBERRY CLOVER. *Trifolium fragiferum.* So called from the fruit-like aspect of its calyces (bracts) which expand and then take on, especially on clay soil, a reddish color after the flowers fade. Called also Strawberry-headed Trefoil, and in Germany, Earthberry (strawberry) Clover, Bladder Clover and Red Creeping Clover.

STRIPED FLOWERED CLOVER. *Trifolium involucratum.* (Miller, Dict. of Eng. Names of Pl.)

SUBTERRANEAN CLOVER. *Trifolium subterraneum.*

SUCKLING CLOVER. *Trifolium filiforme.* So called because formerly recommended in England for cultivation for young calves. Owing however to its annual habit and small yield it is now seldom grown. It is also known in that country as Yellow Suckling Clover, Slender Clover and Small-Flowered Clover. In Germany it is called Thread Clover, Slender-Stalked Clover, Little Yellow Hop Clover and Golden Clover.

SULLA. *Hedysarum coronarium.* See French Honeysuckle.

SULPHUR CLOVER. *Trifolium ochrolcucum.* (Miller, Dict. of Eng. Names of Plants, 1884.)

SWAMP CLOVER. *Menyanthes trifoliata.* Water Clover; Fever Clover; Castor Clover; Goat Clover.

SWAMP HORN CLOVER. *Lotus ulginosus.*

SWEDISH CLOVER. *Trifolium hybridum.* See Alsike Clover.

SWEDISH LUZERNE. *Medicago falcata.* See Yellow Lucern.

SWEET CLOVER. 1. *Melilotus alba.* The popular name for this species in the United States, where it is occasionally grown as an ornamental plant and for other purposes. The name is sometimes extended also to the entire genus Melilotus. Besides the above name this species is called Bokhara Clover (of which name there are several variations in spelling), Large White Clover, Tree Clover, Cabul Clover, and in Germany White Stone Clover, Wonder Clover, White Giant Clover and Hemp Clover. See Yellow Sweet Clover. 2. *Onobrychis sativa.* So called in Germany. See Sainfoin.

SWEET-SCENTED CLOVER. *Melilotus alba.* See Sweet Clover.

SWEET TREFOIL. *Lotus corniculatus.* See Bird's Foot Trefoil.

TALL CLOVER. *Trifolium medium.* See Mammoth Clover.

THREAD CLOVER. *Trifolium filiforme.* See Suckling Clover.

TICK TREFOIL. The genus *Desmodium.* See Honeysuckle, Cock's Head and Florida Clover.

TOOTHED MEDICK. *Medicago denticulata.* See Burr Clover.

TOOTHED STONE CLOVER. *Melilotus dentatus.*

TREACLE CLOVER. *Psoralea bituminosa.* See Bituminous Clover.

TREE CLOVER. *Melilotus alba.* See Sweet Clover.

TURKISH CLOVER. 1. *Trifolium pratense.* 2. *Onobrychis sativa.* Both so called in Germany. See Red Clover and Sainfoin.

UMBELLED CLOVER. (Doldenklee.) *Lotus corniculatus.* See Bird's-foot Trefoil.

UPRIGHT CLOVER. *Trifolum strictum.*

VIOLET CLOVER. *Lespedeza violacea.* The usual name for this species, called by Killebrew Purple Bush Clover.

WATER CLOVER. *Menyanthes trifoliata.* See Swamp Clover.

WELSH CLOVER. 1. *Trifolium pratense.* (Stebler & Schröter.) See Red Clover. 2. *T. arvense* (Darlington). See Rabbit-foot Clover. 3. *Medicago sativa.* See Alfalfa.

WEST INDIAN HONEYSUCKLE. A name for the genus *Desmodium*, more often called Tick Trefoil, (Miller, Eng. Names of Pl.)

WHITE BOKHARA CLOVER. *Melilotus altissima Sibirica.* See Siberrian Giant Clover.

WHITE CLOVER. *Trifolium repens.* The name always applied to this species in the United States, and often in other countries. Thus, *French*, Triolet and Trefle Blanche or Blanc; *Spanish*, Trefol Blanco; *German*, Weisser Klee. In Great Britain, however, it is usually known in trade as Dutch Clover. It has also the names, White Trefoil, White Meadow Trefoil, Creeping Trifolium, Creeping Clover, Stone Clover in part, Honeysuckle, Honeysuckle Grass, Honeysuckle Clover and Shamrock. In Germany it is also known as Lamb and Sheep Clover, Field Clover, Bee Clover and Little Clover.

WHITE DUTCH CLOVER. *Trifolium repens.* (Philip Miller, 1726.) See Dutch Clover and White Clover.

WHITE MEADOW TREFOIL. *Trifolium repens.* (Philip Miller, 1726.) See White Clover.

WHITE STONE CLOVER. *Melilotus alba.* See Sweet Clover.

WHITE SWEDISH CLOVER. *Trifolium hybridum.* See Alsike Clover.

WHITE TREFOIL. *Trifolium repens.* See White Clover.

WILD CLOVER. *Trifolium pratense.* A name applied to this species in southern Spain, where in the coast districts it occurs spontaneously in the natural pastures. (U. S. Consular Reps., Cattle and Dairy Farming, 1887, p. 385.) See Red Clover.

WINTER CLOVER. *Mitchella repens.* (Partridge-Berry.) (Miller, Dict. of Eng. Names of Pl., 1884.)

WOLF CLOVER. *Medicago lupulina.* A German name. See Black Medick.

WONDER CLOVER. *Melilotus alba.* (Haage & Schmidt, Cat., 1894.) See Sweet Clover.

WORMS. *Astragalus hamosus.* (Thorburn, 1893.)

WOUND CLOVER. *Anthyllis Vulneraria.* See Wound-wort.

WOUND WORT. *Anthyllis Vulneraria.* Sand Clover; Yellow Clover; Yellow Sand Trefoil; Common Kidney Vetch; Lady's Fingers; Lamb's Toe; Wound Clover, and in Germany Fir Clover, Wool-flower Clover, Cat Clover and Breast Clover.

YELLOW CAT CLOVER. Applied in Germany to Hop Trefoil, probably *Medicago lupulina.* See Black Medick and Hop Clover.

YELLOW CLOVER. 1. *Trifolium procumbens.* See Hop Clover. 2. *T. minus* (*T. procumbens, var. minus*), (Miller, Dict. of Eng. Names of Pl.) 3. *T. agrarium.* (Gray's Manual, 1889.) See Golden Clover. 4. *Anthyllis Vulneraria.* See Wound-wort. 5. *Medicago lupulina.* This has long been known in England as Yellow Clover and is now known in Germany as Yellow or Hop Clover. See Black Medick. 6. *Lotus corniculatus.* "Yellow Trefoil." (Tr. of Bot.)

YELLOW HOP CLOVER. *Trifolium agrarium.* Often so called in the United States. See Golden Clover.

YELLOW LUZERNE. *Medicago falcata.* Known also in England as Yellow Moon Trefoil. Called in France *Lucerne en famille* or *Luzerne*

de Suède. In Germany it is known as Dutch Clover, Yellow Clover, Swedish Luzerne, Yellow Sickle Clover, Stone Clover in part, Swedish Clover, Sickle-podded Clover, Large Yellow Snail Clover, Burgundy Luzerne, Wild Healing Hay and Yellow Mountain Luzerne. In France the name Yellow Luzerne is applied to *Medicago lupulina.* (Baillon.) See Black Medick.

YELLOW MEADOW TREFOIL. *Trifolium agrarium.* (Philip Miller, 1726.) See Golden Clover.

YELLOW MOON TREFOIL. *Medicago falcata.* See Yellow Luzerne.

YELLOW STONE CLOVER. *Melilotus officinalis.* See Yellow Sweet Clover and Stone Clover.

YELLOW SUCKLING CLOVER. *Trifolium filiforme.* See Suckling Clover.

YELLOW SWEET CLOVER. *Melilotus officinalis.* Called in England King's Clover, Hart's Clover, Plaster Clover, Melilot Clover, Common Melilot and Wild Laburnum. In France it is known as Oat Melilot and Dog Clover, in Germany as Yellow Stone Clover, Branching Stone Clover, Giant Clover and Giant Melilot Clover. Compare Large Rooted Sweet Clover.

ZIGZAG CLOVER. *Trifolium medium.* One of the names applied in England to this species on account of its somewhat zigzag stems. Names similar to this are applied to this Clover in Germany. See Mammoth Clover.

LIST OF GENERA AND SPECIES.

Anthyllis Vulneraria, Wound-wort.
Astragalus caryocarpus, Buffalo Clover, erroneously.
    hamosus, Worms.
Chrysanthemum Leucanthemum (Oxeye Daisy), Rhode Island Clover.
Cytisus sessilifolius, Gardener's Clover.
Desmodium tortuosum (Beggar-weed) Florida Clover.
Erodium cicutarium, Alfilaria.
Galega officinalis, Goat's Rue.
Hedysarum Canadense, Canada Bush Clover.
    coronarium, French Honeysuckle.
Lespedeza capitata, Round-Headed Bush Clover.
    frutescens, Bush Clover.
    hirta, Hairy Bush Clover.
    repens, Creeping Bush Clover.
    striata, Japan Clover.
    violacea, Violet Clover.
Lotus corniculatus, Bird's-foot Trefoil.
    uliginosus, Swamp Horn-Clover.
Medicago denticulata, Burr Clover.
    Echinus, Clover of Calvary.
    falcata, Yellow Lucerne.
    hispida, Bristly-Haired Snail Clover.
    lappacea, Snail Clover.
    littoralis, Seashore Snail Clover.
    lupulina, Black Medick.
    maculata, Spotted Medick.
    media, Sand Lucerne.
    rigidula, Rigid Snail Clover.

Melilotus alba, Sweet Clover.
altissima Sibirica, Siberian Giant Clover.
cœruleus, Balsam Clover.
dentatus, Toothed Stone Clover.
macrorrhizus, Large-Rooted Sweet Clover.
Ornithopus sativus, Serradella.
Oxalis Acetosella (Common Wood Sorrel), Sour Clover.
stricta, L., Stiff Sour Clover.
Petalostemon, Prairie Clover.
Psoralea bituminosa, Bituminous Clover.
Richardsonia scabra, Mexican Clover.
Scorpiurus vermiculatus, Caterpillars.
Trifolium agrarium, Golden Clover.
Alexandrinum, Egyptian Clover.
alpestre, Oval-headed Clover.
alpinum, Alpine Clover.
arvense, Rabbit-foot Clover.
badium, Brown Clover.
Bocconi, Bocconi's Clover.
Carolinianum, Carolina Clover.
filiforme, Suckling Clover.
fragiferum, Strawberry Clover.
glomeratum, Clustered Clover.
hybridum, Alsike Clover.
incarnatum, Crimson Clover.
involucratum, Striped-flowered Clover.
Lupinaster, Bastard Lupine.
maritimum, Seaside Clover.
medium, Mammoth Clover.
ochroleucum, Sulphur Clover.
pratense, Red Clover.
pratense perenne (so called), Perennial Red Clover.
procumbens, Hop Clover.
reflexum, Buffalo Clover.
repens, White Clover.
resupinatum, Reversed Clover.
rubens, Reddish Clover.
scabrum, Rough Clover.
spumosum, Bladder-podded Clover.
stellatum, Starry Clover.
stoloniferum, Running Clover.
striatum, Knotted Clover.
strictum, Upright Clover.
subrotundum, Mayad Clover.
subterraneum, Subterranean Clover.
suffocatum, Sand Clover.
Trigonella fœnum-græcum, Fenugreek.

ALFALFA.

The prolonged drouth of last season, extending almost unbroken from the middle of June to the first of September, brought out more prominently than usual the merits of alfalfa as a plant for resisting dry weather. This forage plant is but little grown in Michigan, or in any part of the United States having a severe climate. In some parts of Germany, however, where the winters are said to be as cold as ours, it is highly prized. It is somewhat difficult to secure a good stand of alfalfa in this state, owing partly to the small growth which it makes the first season, rendering it liable to be choked by weeds, and to the fact that it sometimes heaves out in winter on damp, heavy soil, particularly the first winter. If the ordinary grasses are sown with it, however, the loss of some of the plants is not so serious. To secure the best results from alfalfa it should, unless used for pasture, be cut several times during the season. If allowed to stand too long the stems not only become hard and unpalatable, but cease growing and yield a smaller amount of valuable fodder than if the cutting is repeated as often as the plant commences to blossom. I know of no forage plant which withstands repeated cutting better than this, or which grows up more quickly when cut. It appears to be a benefit to the plant rather than otherwise to be cut down when it has reached about its full size and the leaves have begun to lose their freshness. The prompt cutting of the crop when it has reached this stage is particularly desirable the first season, as thereby the weeds which are likely to be abundant the first year are checked in growth, while the alfalfa starts with renewed vigor. At this station a plot sown in the spring of 1894 started well and grew more rapidly for the first few weeks than the ordinary clovers, but upon the advent of dry weather in the latter part of June it ceased growing and commenced to blossom, although only six to nine inches high. The leaves began to fade, turn blue and drop off. On July 2 the plot was mowed, after which the alfalfa put forth again, and remained green and thrifty for the remainder of the season. An older plot of half an acre, which contained some timothy, was cut when the timothy was ready, June 18. It was then in full bloom. A second cutting was made September 1 of about a ton and a half per acre of pure alfalfa, no timothy having made its appearance. By October 1 the alfalfa was again up, a foot to a foot and a half high, and the timothy had also been revived by the fall rains. The alfalfa was slightly injured by a hard frost on the 15th of October but remained for the most part green and fresh until hard freezing weather near the middle of November.

During the following winter no injury occurred to any of the plots of alfalfa and it was one of the earliest plants to start in the spring. The half acre plot of mixed alfalfa and timothy was cut for hay June 6, just as the alfalfa was coming into blossom. It yielded, 718 pounds of alfalfa, mixed with some June grass, the season having been so dry up to that time that the timothy had scarcely started. On a low portion of this plot the alfalfa was greatly damaged, and some of it killed to the ground, by the uncommonly hard freezes of May 12 to 15.

Another piece of alfalfa, about two acres in extent, was sown this spring (1895) the 6th of April on a piece of fall plowing, as soon as the land was ready to work. The location was a dry, sandy hill. A light top dressing

of ashes and fine barn yard manure was given after the seed was harrowed in. There is now (June 24) a fine stand of thrifty plants, six to ten inches high, with a good many weeds on a part of the plot. It is intended to go over the field with a mower about the first of July.

Alfalfa is recommended for further trial throughout the state and reports are invited from those who succeed or fail with it.

The following points regarding alfalfa are to be noted.

1. It is especially adapted to withstand dry weather.
2. It has no serious insect or fungous enemies.
3. The seed costs no more than clover seed.
4. It starts in spring with more certainty and greater vigor than clover.
5. It is more particular than clover in regard to soil.
6. The soil should be deep and well drained, and naturally fertile or fertilized at the time of seeding.
7. The seed should be sown in the spring without any other crop, in the same manner as the ordinary spring grains.
8. The field should be mown about the first of July, or when the alfalfa has about ceased growing and before the weeds have ripened their seed.
9. Each year thereafter the alfalfa should be cut as often as it commences to blossom.

TEMPERATURES OF DIFFERENT SOILS.

Following is a condensed report of observations made in 1891 by Mr. D. J. Crosby on the temperatures of different soils under various conditions.

First, *Evaporation and Soil Temperature.* Four granite ironware dishes, each 2½ inches deep and holding about two quarts, were filled with soil, one each of sand, clay, loam and muck. These were placed in an evaporating oven, kept at 212° F., until all the water had evaporated. To each dish was then added 16 ozs. of water, which the earth absorbed, when the dishes were all placed in an exposed situation out of doors. A thermometer was placed in the soil of each, extending to the bottom of the dish. The reading of the thermometer, and the weight of each sample of soil, were taken daily except Sunday for a period of nine days, from August 18 to 26, inclusive. At first the observations were taken hourly during the day time, afterward at longer intervals. The table below shows the per cent of the moisture which had evaporated from each kind of soil at successive periods of time, and its average temperature for the whole period.

Soil.	5 hours.	10 hours.	20 hours.	30 hours.	50 hours.	70 hours.	97 hours.	147 hours.	197 hours.	Average temp.
Sand	25.8	35.9	40.6	75.	84.4	90.6	dry	....	....	87.6
Clay	25.8	34.4	38.3	71.9	82.	87.5	98.7	96.9	99.2	88.7
Loam	28.1	36.7	40.6	69.5	74.2	78.1	85.1	89.	91.4	90.2
Muck	22.6	25.8	26.5	37.5	41.4	45.3	54.2	59.4	62.5	92.1

From the above it will be seen that the sand dried the most rapidly and the muck the slowest while the average temperatures increased, in the reverse order, from the sand through the clay and loam to the muck, which was the warmest. The experiment was then varied by taking four boxes, one for each kind of earth, the boxes being each one foot deep and two feet square, with perforated bottoms. These were sunk in the open ground until their tops were level with the surface and then left several weeks to settle. Hourly observations then taken at the surface of the soil during the daytime for two successive days, August 18 and 19, gave the following average temperatures: sand 96.3°, clay 96.4°, loam, 99.2°, muck 102.4°, the order of temperatures thus being the same as before. Another set of readings, extending from August 4 to 17 inclusive, at three different depths, gave the following:

	Average temperatures.		
	Surface.	Three inches.	Six inches.
Sand	92.6	86.5	80.3
Clay	93.	86.7	81.6
Loam	94.6	86.3	79.8
Muck	96.9	84.5	77.

Here it appears that the relative temperatures at the surface do not necessarily hold for lower depths, for the muck, which was the warmest of the four soils at the surface was at the depth of six inches the coldest. The question then arose to what condition or conditions of these soils were these differences in temperature due? The fact that the surface temperature increased from the light colored sand through the clay and loam to the dark colored muck suggested an examination first into the influence of color. One-half of the box of sand, above mentioned, was therefore covered with lampblack and half of the box of muck covered with lime. The temperatures of each half of each box, at the surface and at depths of three and six inches, were then taken for a period of six days, with results which are summarized in the following table:

Sand.						Muck.					
Black.			Uncolored.			Uncolored.			White.		
Surface.	Three inches.	Six inches.	Surface.	Three inches.	Six inches.	Surface.	Three inches.	Six inches.	Surface.	Three inches.	Six inches.
95.3°	79.1°	70. °	83.7°	77.3°	69.5°	91.7°	77.5°	64.7°	82.2°	78.5°	63.4°

Average temperature for the black (colored) sand, 78.6°, for the uncolored sand, 76.8°.

Average temperature for the black muck (natural color), 78°, for the white (limed) muck, 73°.

These figures indicate that muck itself is not warmer than sand, but, on the contrary, that when sand is colored dark like muck it is the warmer of the two. In both cases it appears that the soil with the dark surface, whether natural or artificially colored was the warmer. It seems also, from an inspection of the table, that even at a depth of six inches an increased temperature was found under the darker surfaces. These observations were repeated with different soils and with thermometers placed at depths extending to seven inches, the highest temperatures being still found under the dark colored surfaces.

PLANTING AT DIFFERENT DEPTHS.

In 1891, Mr. Fred P. Clark, then a student at the College, conducted under the direction of Prof. P. G. Holden a brief series of experiments on the vegetation of seeds planted at depths varying from one-half inch up to twelve inches. The test was made on three classes of soil, sand, loam and clay, the earth being placed in 24 boxes, eight for each kind of soil. In each box was planted ten seeds of each of the following kinds: Wheat, oats, flax, corn, barley, clover, peas and buckwheat. The same number of seeds of each, previously tested in a seed tester, had germinated as follows: Wheat ten, oats nine, flax ten, corn ten, barley five, clover seven, peas ten, buckwheat five. In the first set of three boxes (one each of sand, loam, and clay) the seeds were planted half an inch deep, in the second set one inch deep and so on as shown in the table. The planting was done July 20 and the boxes all watered upon each alternate day thereafter. The plants began to appear above the surface from the shallow planting July 24 and continued to come up from the deeper plantings until August 8. The table gives the total germinations for each depth.

Table of germinations.

	Depth in inches.	Wheat.	Oats.	Flax.	Corn.	Barley.	Clover.	Peas.	Buck-wheat.
Sand	½	9	6		9	6	3	1	3
	1	9	10	5	7	2	3	1	3
	2	7	10	5	8	5	2		2
	4	7	5		10	3		6	1
	6	4	9		9	4		2	
	8		2		8	1		4	
	10		1		6			4	
	12							2	
	Total	36	43	10	57	21	8	20	9
Loam	½	9	10	9	10	6	7	10	5
	1	9	8	10	10	4	6	7	3
	2	5	10	8	3	4	3	3	7
	4	6	9	10	4			9	3
	6	5	10		7	2		9	3
	8		8		6			10	
	10		3		3			5	
	12		1		1			6	
	Total	34	59	37	44	16	16	59	21
Clay	½	8	10	5	6	2	1	4	6
	1	10	9	8	10	6	8	10	9
	2	9	10	9	10	3		10	7
	4	8	6		9	4		9	3
	6	4	6		9	2		8	
	8		6		8			9	
	10		2		2			8	
	12				1			6	
	Total	39	49	22	55	17	9	64	25

Total for all soils.

Depths in inches	½	1	2	4	6	8	10	12
Wheat	26	28	21	21	18			
Oats	26	27	30	20	25	16	6	1
Flax	14	23	22	10				
Corn	25	27	21	23	25	22	11	2
Barley	14	12	12	7	8	1		
Clover	11	17	5					
Peas	15	18	13	24	19	23	17	14
Buckwheat	14	15	16	7	3			

From the above it appears that in this test the clover entirely failed below two inches, that oats, corn and peas were able to grow from a depth exceeding eight inches and that peas withstood deep planting the best of all.

HARVESTING WHEAT AT SUCCESSIVE STAGES OF RIPENESS.

In 1891 the following experiment was conducted by Mr. L. J. Briggs, under the direction of Prof. P. G. Holden, for the purpose of determining the effect upon the weight of the grain, and upon its germinating vigor, of harvesting wheat at four different stages of ripeness and afterwards subjecting it to different methods of treatment. The stages of ripeness were the milky stage, the dough stage, yellow ripe and dead ripe. The methods of treatment were as follows:

1. One hundred grains at each stage of maturity were shelled out and weighed immediately upon cutting, giving the weights which appear in the first column of the table.

2. In the second column are the weights of four similar samples of 100 seeds each from grain which was left in the head detached from the straw until matured.

3. In the next series the straw was cut the usual length and the grain left in the heads upon the straw until fully cured.

4. The last treatment consisted in placing the entire stems with the roots attached, but thoroughly cleansed from adhering soil, in a jar of distilled water in a light airy basement until all were thoroughly ripened, replenishing the water as it evaporated.

The one hundred seeds for each weighing were selected as follows: At each stage of maturity ten heads were selected for each method of treatment, the heads chosen being of medium size and as uniform as possible. From each of the ten heads in a given treatment ten seeds were selected from the middle of the head, making the number of seeds required for weighing. The variety employed was that known as Connecticut White.

Table of wheat cut at successive stages of maturity and subjected to different treatments.

(The figures indicate the weights, in milligrams, of 100 kernels.)

Time of harvesting.	Shelled and weighed immediately upon cutting.	Ripened in the head.	Ripened in the straw.	Ripened with the roots on.	Average weights at successive stages of maturity.
June 19, milky stage	1057	1112	1521	1905	1400
June 30, dough stage	3868	3852	4051	4083	3962
July 13, yellow ripe	4850	4955	5035	5190	5008
July 24, dead ripe	4835	4917	5030	4665	4862
Average weights for the different treatments	3652	3709	3909	3960	

From the table it will be seen that the weight of the grain increased at the successive periods of cutting up to the last, or dead ripe stage, where there was a slight falling off from the weights obtained at the yellow ripe period. It also appears that the grain derives additional weight from the straw after cutting, even after it seems to be fully ripe, and considerably more from the entire straw than from detached heads.

THE EFFECT UPON ITS GERMINATING VIGOR OF CUTTING WHEAT AT DIFFERENT STAGES OF MATURITY.

Twenty seeds from each of the samples of wheat described in the foregoing experiment were placed in a Geneva seed tester and subjected to uniform treatment to note the effect of the several stages of maturity and methods of treatment above mentioned upon their germination.

The measurements indicated upon the lower line were taken when all the plants had nearly ceased growing and a short time before they died. The plants had been supplied with water only and were allowed to grow as long as they would under the given conditions.

From the following table it appears that the wheat gathered in the milky stage was much the earliest to germinate, but that its percentage of germination was the lowest. It was also noticed at the time that the plants were feeble and pale in color, and were soon overtaken and passed in growth by those from seed which was more mature. Of the plants from seed in the other three stages those from the yellow ripe seed were a little larger and more vigorous than those from either the dead ripe seed or from seed gathered while in the dough. The latter plants partook somewhat of the character of those from the seed collected while in the milk. From the above experiments it would appear that in wheat nothing is gained either in yield or in the germinating vigor of the seed by allowing the grain to become dead ripe before harvesting.

Dates of examination.	Hours from planting.	Milky stage.					Dough stage.					Yellow ripe.					Dead ripe.				
		Taken from head.	Left in head.	Left in straw.	Roots in water.	Total germinated.	Taken from head.	Left in head.	Left in straw.	Roots in water.	Total germinated.	Taken from head.	Left in head.	Left in straw.	Roots in water.	Total germinated.	Taken from head.	Left in head.	Left in straw.	Roots in water.	Total germinated.
October 31, 7 p. m.	30	6	10	19	20	55	4	0	0	0	4	1	0	0	0	1	0	0	0	0	0
October 31, 12 midnight	35	16	20	20	20	76	17	2	5	6	30	9	1	6	1	17	4	8	4	10	21
November 1, 7 a. m.	42	17	20	20	20	77	20	12	18	17	67	17	12	18	14	61	18	20	20	18	76
November 1, 7 p. m.	54	18	20	20	20	78	20	19	20	20	79	20	20	20	19	79	20	20	20	20	80
November 2, 1 p. m.	72	18	20	20	20	78	20	19	20	20	79	20	20	20	20	80	20	20	20	20	80
Height of best spears in inches	.....	6	6	8	8	.....	9.9	9.5	9.8	10.5	.....	11	11.2	10.9	.....	.....	10.8	10.9	10.8	9.8	.....

DETASSELING CORN.

It has been suggested that by removing the tassels from Indian corn, thus preventing the formation of pollen, a larger growth of ears might be obtained. To determine whether such would be the result and whether the operation could be performed at a profit for the labor expended, the experiment has been performed at several of the state experiment stations within the past few years with somewhat varying results. One of the earliest of these experiments, made at Cornell University, showed an apparent gain by the operation of nearly fifty per cent in the yield of grain. Several other trials, there and elsewhere, showed apparent gains, but more recent experiments have showed little or no gain from the operation, save usually an increase in the number of nubbins or small ears. In regard to some of these later experiments it has been noted that the tassels had attained considerable development before their removal, which it is thought might account for the unfavorable results in these cases.

At the suggestion of Prof. C. D. Smith, in charge of this department, and now director of the station, a repetition of this experiment was undertaken by this station the past season. The work was mostly performed by Mr. Jos. T. Berry, a student in the college. The experiment was located in the east end of a seventeen acre field of white dent and comprised twenty rows, of 180 hills each, extending across the end of the field, amounting to 1⅛ acres. The land was uneven, being traversed by a low piece of ground, through which all the rows passed to higher land at either end. The season being very dry there was but little good corn except on the low land. The rows were numbered consecutively and the tassels removed from each alternate row, half of the rows being left entire to furnish pollen for all. The tassels were removed every week day with a few exceptions during a period of nearly one month, from July 16 to August 11 as shown in the following table. A few small stalks produced tassels after the latter date, but none that would produce ears and they were allowed to remain.

Table showing number of tassels removed at different dates.

Row.	July 16.	July 17.	July 19.	July 20.	July 21.	July 23.	July 24.	July 25.	July 26.	July 27.	July 28.	July 30.	July 31.	August 1.	August 2.	August 3.	August 6.	August 11.
2	24	9	8	32	5	54	------	90	------	53	38	187	33	50	28	18	0	29
4	25	3	7	9	13	60	------	91	------	46	48	196	17	48	30	23	7	26
6	14	11	7	10	25	55	------	70	------	62	65	141	15	80	33	13	5	22
8	13	8	4	----	36	77	------	51	------	41	68	162	50	48	27	16	2	21
10	23	12	2	----	32	88	------	67	------	55	58	148	30	46	14	22	5	19
12	14	26	4	----	30	40	------	------	172	19	47	150	65	27	27	15	3	20
14	23	8	8	----	17	63	------	------	172	23	37	84	45	48	23	20	2	17
16	6	13	12	----	33	47	------	------	145	17	40	84	60	20	30	13	6	18
18	11	10	6	----	23	----	154	------	61	36	34	134	40	52	21	22	2	31
20	8	11	4	----	18	----	61	------	85	20	29	124	44	45	26	12	3	29

The operation of removing the tassels was not performed without some injury to the plants. The desire was to remove the tassels as early as practicable in their development, in order to obtain as great an effect as possible from their removal. It was found that by unrolling the upper leaves, particularly on a warm afternoon when somewhat wilted, the tassel could often be reached and removed before it had made any outward appearance. But even at this early stage on very hot days and in small plants the pollen had already in some cases begun to be liberated. Removal of the tassel so early, however, was usually attended by more or less injury to the leaves. These young tassels were more liable than the older ones to bring away with them one or two of the upper leaves. The displacement of the leaves in removing the tassels so young also worked injuriously, since the delicate surfaces unaccustomed to the sun were frequently scorched during the hot dry weather which prevailed. For this reason the tassels were usually allowed to remain until about half emerged from the leaves. Even then the leaves occasionally came away with them. A steady prolonged pull proved less liable to bring out leaves with the tassel than a sudden one, and it was found that grasping the upper portion of the stalk with one hand while the tassel was removed with the other aided materially in retaining the leaves. With a little practice the work could be performed quite successfully and rapidly. A record was kept of the number of leaves destroyed on each row which was as follows, the numbers indicating the detasseled rows in order from two to twenty: 58, 34, 50, 32, 55, 47, 30, 34, 42, 37. This does not indicate the full extent of the injury, since on many of the hills the upper leaves which remained were scorched by the sun, as above stated, or broken over owing to the removal, while they were young, of the supporting tassel. The effect of this injury must have been to reduce any advantage to be gained from the detasseling. The extent of such injury could perhaps have been lessened somewhat by greater care and previous experience. But to have prevented it altogether would have necessitated allowing the tassels to remain until fully expanded, by which time most of the pollen would have matured and any benefit from the detasseling almost wholly lost.

As soon as silks began to appear they were counted at intervals of about three days on both detasseled and untreated rows. The results are given in part in the following table:

Number of silks visible at successive dates on normal and detasseled rows. (The even numbered rows were detasseled.)

Row.	July 28.	July 30.	August 3.	August 10.	August 20.
1	9	69	194	281	508
2	28	100	268	364	583
3	14	52	178	264	466
4	15	105	285	414	462
5	9	54	181	293	479
6	16	108	293	427	644
7	9	57	162	278	518
8	14	113	276	392	516
9	12	60	172	304	539
10	20	167	351	441	648
11	11	72	217	323	546
12	18	105	315	297	675
13	14	41	152	279	518
14	15	123	316	411	629
15	6	49	160	267	433
16	8	95	261	419	593
17	6	37	139	276	411
18	5	93	277	432	539
19	12	45	116	301	469
20	9	106	206	406	622

It will be noticed that the silks appeared earlier on the rows that were detasseled. At the second counting, July 30, the number of silks which had appeared on the detasseled rows was a little more than double the number that had appeared on the untreated rows, averaging 109½ for the former and 53 for the latter. The proportion in favor of the detasseled rows diminished somewhat thereafter, but the number at the close remained about 20% greater than on the others. The detasseling therefore had a decided effect on the silks, increasing their number and causing them to put forth earlier. The increase in the number of silks appeared to be due partly to the production of several silks upon stalks which otherwise would have produced but one and partly to the appearance of silks upon stalks so small and feeble that but for the detasseling no silk would have made its appearance. Had the soil been uniformly good and the season more favorable, so that all the stalks could have more uniformly and fully developed, the total number of silks appearing upon the two sets of rows during the season would probably have been more nearly equal. But the same condition would doubtless also have enabled the first stimulating effect of the detasseling to have made its appearance more nearly at once throughout the field and thus have caused the average increase in the earliness of the silks due to the operation to have been even greater than it was.

In harvesting the crop each row was shocked and husked by itself. The husking of the first ten rows was done upon September 26, and that of the second ten upon the following day, the corn, with the exception of the gleanings, being hauled to the barn and weighed on the day it was husked. The stalks were weighed October 10 and 11. The results were as follows:

Yield from detasseled and untreated rows (the even rows detasseled).

Row.	Pounds of ears.	Pounds of fodder.	Row.	Pounds of ears.	Pounds of fodder.
1	104.75	164.1	11	108.50	187.8
2	98.50	142.2	12	132.62	152.0
3	93.00	146.1	13	98.00	151.8
4	127.25	151.3	14	114.79	147.0
5	102.50	167.4	15	85.79	160.7
6	123.50	130.8	16	107.31	169.0
7	118.38	158.3	17	88.00	140.0
8	113.12	127.0	18	57.94	89.0
9	118.50	160.7	19	131.00	135.7
10	130.25	119.0	20	95.37	152.0

Total corn on the ten detasseled rows	1,100.56	pounds
" " " " " untreated "	1,046.31	"
Apparent gain in corn from detasseling	54.25	"
Total fodder on the ten untreated rows	1,573.2	pounds
" " " " " detasseled "	1,378.3	"
Apparent loss in fodder from detasseling	194.9	"

It will be seen upon examination that seven out of the ten detasseled rows gave an increased yield of corn over either of the adjoining rows, while two gave a smaller and one an intermediate yield. The total apparent gain by the operation was 54.25 pounds of ears, or a little over 5 per cent. The yield of fodder on the other hand was less on the detasseled rows. The time required for the operation of detasseling averaged about 2½ hours a day for 15 days, or a total of nearly four days' time for a gain of less than a bushel of corn, not taking into account the loss in fodder. For practical purposes the work might have been done with a little less care in somewhat less time, and in a favorable season would doubtless have given rather better results, but we cannot see from the results of this experiment, nor from those at other stations taken as a whole, how the operation can be made financially profitable.

AGRICULTURAL COLLEGE, MICH.,
June 29, 1895.

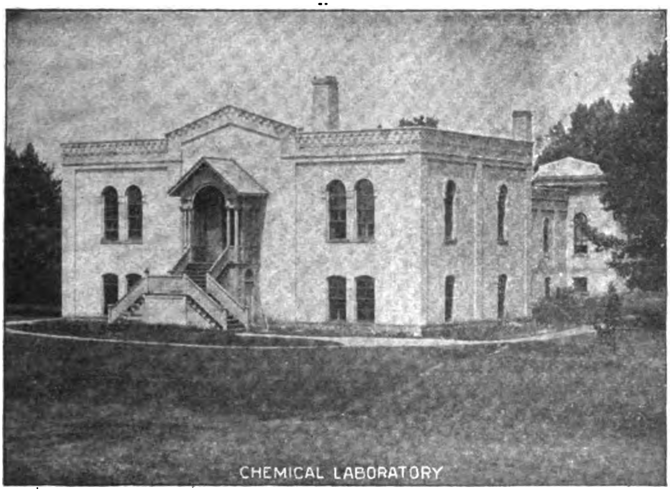
BULLETIN 126 JUNE, 1895

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

CHEMICAL DEPARTMENT



FERTILIZER ANALYSES

BY R. C. KEDZIE

CHEMIST OF THE EXPERIMENT STATION

AGRICULTURAL COLLEGE, MICH.
1895

FARM HOME READING CIRCLE

OF THE

MICHIGAN AGRICULTURAL COLLEGE.

The Michigan Agricultural College maintains a college extension course of reading designed especially for farmers, gardeners, fruit growers and stock breeders. This course is open to all who are interested. The college is especially earnest in its desire to bring the college nearer to the farmer by a thorough dissemination of the latest knowledge relating to agriculture. We invite the co-operation of all progressive farmers in this matter. The Farm Home Reading Circle offers a course in systematic reading on subjects of practical interest to every farmer. The expenses of maintaining the course are paid from a special appropriation by the State Board of Agriculture. There are no expenses to members except the purchase of books. We have already a large and rapidly increasing number of readers and the enthusiasm of those who have taken up the course is very gratifying. Send a postal card for full information.

L. G. GORTON, *President of the College.*

F. B. MUMFORD, *Agricultural College, Mich.*

BULLETIN 126 JUNE, 1895

MICHIGAN

STATE AGRICULTURAL COLLEGE

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FERTILIZER ANALYSES

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AGRICULTURAL COLLEGE, MICH.

1895

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

MICHIGAN AGRICULTURAL EXPERIMENT STATION.

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SUB-STATIONS.

Grayling, Crawford County, 80 acres deeded.
South Haven Van Buren County, 10 acres rented; 5 acres deeded.

INSPECTION OF COMMERCIAL FERTILIZERS.

The law requiring the inspection and licensing of commercial fertilizers whose retail price exceeds ten dollars a ton, has been in force ten years. It has effected great changes in the composition and value of such fertilizers. Designed in the first place for the protection of farmers, it has incidentally proved a protection to reputable dealers by excluding the materials of a worthless class and by saving them from the competition of unscrupulous manufacturers.

OBJECT OF CHEMICAL ANALYSIS.

In the analysis of commercial fertilizers attention is directed exclusively to nitrogen, potash and phosphoric acid, in forms available for food of the plant. These are of such great importance that they have well been called the *tripod of agriculture.* They are not the only materials that serve as food of plants, but they are the only manurial materials for which the farmer can afford to pay more than ten dollars a ton. The common materials which make up the body of our soils, such as lime, magnesia, alumina, silicia and oxide of iron, the farmer cannot afford to buy as manure at twenty to forty dollars a ton, to apply to his fields made up of the same materials. The farmer buys his land by the acre and not by the ton. The claim of some fertilizers that they contain all these soil materials may be proof of their small value. These common constituents of the soil, aside from nitrogen, potash and phosphates, do not enter into consideration in making up an estimate of the value of any fertilizer.

GATHERING SPECIMENS FOR ANALYSIS.

The law requires the manufacturer, importer, etc., to deposit with the Secretary of the State Board of Agriculture a sealed glass jar of the fertilizer with a certified copy of the analysis. But the specimen for analysis is selected in the open market, so as to find the material in the condition it is offered to the farmer. Where there are several packages of the same fertilizer, a handful is taken from each bag, the whole well mixed and then a pound taken for an average sample for analysis. On a card is entered the name of the manufacturer and his address, the trade name of the fertilizer, name of the dealer, the locality and date of collecting. This card is inclosed with the specimen in a tight can or jar and brought to the laboratory for analysis. Where it is possible the specimen is selected in the open market, but in a few instances the manufacturer's specimen is used.

When all the specimens are collected they are analyzed to determine the amount of available nitrogen, estimated as ammonia, the amount of available phosphoric acid—the insoluble phosphoric acid and the amount of potash soluble in water. The results of analysis are entered in a line and in a parallel line the amounts corresponding as claimed by the manufacturer. The results are thus capable of direct comparison.

MANUFACTURERS SHOULD PROTECT THEIR RETAIL DEALERS.

By the proviso to section 3 of the law a dealer in this State is not required to take out a license for the sale of any fertilizer if the manufacturer has taken out a license for such fertilizer. In this way the manufacturer can protect all his agents in this State by payment of a single fee. Otherwise each dealer must take out a license. The object of the law is not merely to collect a revenue, but to secure the analysis and certification of every fertilizer sold in the State. If, then, any manufacturer neglects or refuses to take out a license for his goods, it would be a matter of prudence for all dealers to refuse his goods, and sell only the fertilizers of such manufacturers as will protect their agents in the State. If outside manufacturers neglect their State agents, then the law exacts the fee for license from each dealer in the State.

OBJECT OF INSPECTION OF COMMERCIAL FERTILIZERS.

The law does not prescribe any standard for the composition of a commercial fertilizer, the manufacturer being free to make his own standard, the law simply requiring that the fertilizers offered for sale shall be up to the standard set up by the manufacturer. The license to sell does not certify to the value of the fertilizer, but simply states that the manufacturer or dealer offers for sale a fertilizer for which a certain content of nitrogen, potash and phosphoric acid is claimed, and that samples of such fertilizers have been deposited with the secretary of the college with affidavit regarding the composition. Analysis is then made of each of these fertilizers, gathered in the open market as far possible, and the results of such analysis published in bulletin. The *claimed* composition and *found* composition are arranged in parallel lines, so that the real composition can be compared at a glance with the composition claimed for it by manufacturer. In this way the buyer can see at once by this bulletin whether the fertilizer is as good as the claims made for it.

RESULTS REACHED BY INSPECTION.

In the table of results, the statement is made in parts in one hundred of the fertilizer analyzed or percentage of material found. In the line giving the amount claimed there is often given a minimum and maximum figure. For example under the heading of phosphoric acid, the total P_2O_5 is given in one case 25 to 30, which means that the fertilizer contains at least 25% of P_2O_5 and may contain 30%. In practice the lowest claims are usually what the manufacturer aims to furnish the farmer and are all that he is required to furnish. It is safer to calculate the value of any fertilizer on this minimum claim.

The quality of the fertilizers sold in this State has greatly improved within a few years past. On comparing the composition as "claimed" with that "found" by analysis, it will be seen that in only a few cases

does the minimum claim exceed the amount actually found and in many cases the amount found exceeds the highest amount claimed. The day when a mixture of leached ashes and soap-boilers waste can be sold for superphosphate, or marl palmed off for Buckeye phosphate has passed away in Michigan.

The trade name of a fertilizer does not necessarily indicate its real uses. Thus a dealer may sell an "onion" fertilizer, "strawberry" fertilizer, "cabbage" fertilizer and "lawn" fertilizer, leading his patrons to suppose that they are buying fertilizers specially fitted for these various crops and yet the fertilizers of these several names may all be sold out of one common stock. The special trade name means very little, but the chemical composition means a great deal. The farmer should learn to buy his fertilizers with reference to their chemical composition, instead of a trade name that signifies nothing. He might as well buy his team on the strength of their name without reference to the work they can do. If he finds a fertilizer rich in ammonia, phosphoric acid and potash—a fertilizer that can do good work in raising crops—and if the price is reasonable, that is the kind to buy, no matter what name it bears.

A few manufacturers have failed to take out a license for all the brands of fertilizers they are offering for sale in this State. There have been found fifteen such unlicensed fertilizers on sale during this year, and the list is printed at the close of table of licensed fertilizers. In this list are possibly some regularly licensed fertilizers sold under another name. But the law (Sec. 3) requires of the manufacturer a license fee of $20 for each and every brand of fertilizer he offers for sale in this State. The sale of a fertilizer already licensed under a variety of names without a license for each brand is clearly unlawful.

It may be that some of the manufacturers in this list have forgotten to renew their license, but it would seem that some of them seek to evade the law and sell their goods without complying with the law, thus *giving the public no proof of the value of their goods*. The law was enacted to prevent defrauding the farmer by selling him goods of inferior quality, and at the same time to protect the honest manufacturer in the sale of good fertilizers. The fee that is demanded is not to make money for the State, but simply to pay the expense of collecting specimens of fertilizers in the open market, the analysis of the same, and the license for their sale. By requiring the manufacturer to state under oath the chemical substances he uses in making his fertilizer, and then comparing the composition as claimed by the manufacturer with the results as found by analysis in this laboratory, the farmers have the means of knowing the nature of the several fertilizers offered for sale and can form some estimate of their real value. The law is designed in the first place to protect the farmer, in the second place to protect the honest dealer from the competition of dishonest dealers, and in the third place to expose the cheats. Manifestly if the law is to be enforced upon any, it must be enforced upon all. The reputable dealers would furnish honest goods without the law; it is the evasive fellows that the law aims to reach.

Most of these unlicensed fertilizers come from outside the state, and the law can only reach the local dealers. It may seem like a hardship to enforce the law against the dealers within our State for the neglect of the manufacturers outside the State, but the law has no force outside our State. If these foreign manufacturers are unwilling to place their goods in the open light of day by showing their real composition and thus come

in fair competition with reputable dealers, it would be prudent for dealers to refuse to handle their goods, and thus save themselves from the severe penalty for selling unlicensed fertilizers. It would be wise for farmers to refuse to buy fertilizers whose composition they do not know, and of whose intrinsic value they have no assurance. It would be well to leave such fertilizers severely alone. It is the manifest duty of the Board of Agriculture to enforce the law against the dealers in unlicensed fertilizers. When such dealer has paid a fine of $100 for the sale of an unlicensed fertilizer, he will conclude that there may be more profit in dealing in legitimate goods.

WHAT TO LEARN FROM THE TABLE OF ANALYSIS.

As previously stated the three most valuable materials in commercial fertilizers are potash, phosphoric acid and available nitrogen. Each of these has a commercial value which may be stated in dollars and cents. Only these three substances are considered in the inspection of commercial fertilizers because the other materials are of too little value to be purchased at high prices. By placing before the farmer the composition as claimed by the manufacturer and the composition of the material as found in the market, he can find whether the goods are up to standard and can also form an estimate of the market value of the goods. If the analysis shows more of a given substance than is claimed, the goods are better than claimed; but if much less is found on analysis than is claimed, then the goods are proportionately of less value to the farmer.

The market value of these materials varies somewhat from year to year. The value of nitrogen estimated as ammonia is now 16 cents a pound; of available phosphoric acid, 8 cents a pound; of insoluble phosphoric acid, 2½ cents a pound; and potash is worth 6 cents a pound.

Since there are 20 times 100 pounds in a ton, if we multiply the value of one pound by 20 we find the value of one per cent of any material in a ton. We may thus construct a table for estimating the value of any materials found in the results of analysis. One per cent means 20 pounds in a ton, and if the material is worth 8 cents a pound, then each per cent equals $1.60 for a ton.

Multiply the per cent of available P_2O_5 by	$1 60
" " insoluble P_2O_5 by	50
" " ammonia by	3 20
" " potash by	1 20

The sum of these products will give the market value of the fertilizer.

For example take Garden City Superphosphate:

3.26 % ammonia × $3.20	$10 43
9.23 % available P_2O_5 × $1.60	14 77
3.39 % insoluble P_2O_5 × .50	1 69
.77 % potash × $1.20	92
Market value of a ton	$27 91

The law respecting inspection and licensing of commercial fertilizers is again inserted, because so many seem to be ignorant of its provisions:

[Session Laws of 1885, No. 26.]

AN ACT to provide for the inspection of commercial fertilizers and to regulate the sale thereof.

SECTION 1. *The People of the State of Michigan enact*, That any person or persons who shall sell or offer for sale in this state any commercial fertilizer, the retail price of which exceeds ten dollars per ton, shall affix on the outside of every package containing such fertilizer a plainly printed certificate, stating the number of net pounds therein; the name or trade mark under which such article is sold; the name of the manufacturer, the place of manufacture, and a chemical analysis, stating the percentage of nitrogen in an available form; of potash soluble in water, and of phosphoric acid in available form (soluble or reverted) and the insoluble phosphoric acid.

SEC. 2. Before any commercial fertilizer is sold or offered for sale, the manufacturer, importer, or party who causes it to be sold or offered for sale within this state, shall file with the secretary of the State Board of Agriculture a certified copy of the analysis and certificate referred to in section one, and shall also deposit with said secretary a sealed glass jar containing not less than two pounds of such fertilizer, with an affidavit that it is a fair sample of the article thus to be sold or offered for sale.

SEC. 3. The manufacturer, importer, or agent of any commercial fertilizer, the retail price of which exceeds ten dollars per ton as aforesaid, shall pay annually to the secretary of the State Board of Agriculture, on or before the first day of May, a license fee of twenty dollars for each and every brand of fertilizer he offers for sale in this state: *Provided*, That whenever the manufacturer or importer shall have paid this license fee his agents shall not be required to do so.

SEC. 4. All such analyses of commercial fertilizers required by this act shall be made under the direction of the State Board of Agriculture and paid for out of the funds arising from the license fees provided for in section three. At least one analysis of each fertilizer shall be made annually.

SEC. 5. The secretary of the State Board of Agriculture shall publish in his annual report a correct statement of all analyses made and certificates filed in his office, together with a statement of all moneys received for license fees, and expended for analysis. Any surplus from license fees remaining on hand at the close of the fiscal year shall be placed to the credit of the experimental fund of said board.

SEC. 6. Any person or persons who shall sell or offer for sale any commercial fertilizer in this state without first complying with the provisions of sections one, two, and three of this act, or who shall attach or cause to be attached to any such package or fertilizer an analysis stating that it contains a larger percentage of any one or more of the constituents or ingredients named in section one of this act than it really does contain shall, upon conviction thereof, be fined not less than one hundred dollars for the first offense, and not less than three hundred dollars for every subsequent offense, and the offender shall also be liable for damages sustained by the purchaser of such fertilizer on account of such misrepresentation.

SEC. 7. The State Board of Agriculture by any duly authorized agent is hereby authorized to select from any package of commercial fertilizer exposed for sale in this state, a quantity, not exceeding two pounds, for a sample, such sample to be used for the purposes of an official analysis and for comparison with the certificate filed with the Secretary of the Seate Board of Agriculture and with the certificate affixed to the package on sale.

SEC. 8. All suits for the recovery of fines under the provisions of this act shall be brought under the direction of the State Board of Agriculture.

Approved March 10, 1885.

For the information of the parties concerned, the fertilizers that have been licensed for 1895 are contained in the list of this bulletin; also those that have not been licensed and whose sale is illegal in this state are printed in a separate list.

R. C. KEDZIE,
Chemist of Experiment Station.

AGRICULTURAL COLLEGE,
July 3, 1895.

Analysis of comercial fertilizers

Manufacturer.	Trade name.	Dealer and locality.
Michigan Carbon Works, Detroit, Mich.	Jarves Celery Grower	Geo. Hancock, Grand Haven.
Michigan Carbon Works, Detroit, Mich.	Homestead Bone Black Fertilizer	Geo. Hancock, Grand Haven.
Michigan Carbon Works, Detroit, Mich.	Jarves Drill Phosphate	C. B. Waterloo, Port Huron
Michigan Carbon Works, Detroit, Mich.	Homestead Potato Grower	J. F. Farnum, Kalamazoo
Michigan Carbon Works, Detroit, Mich.	Homestead Vegetable Grower	J. H. St. Johns & Co., Utica
Michigan Carbon Works, Detroit, Mich.	Perfection Fruit Grower and Sandy Soil Fertilizer	Geo. Hancock, Grand Haven.
Michigan Carbon Works, Detroit, Mich.	Banner Dissolved Bone	Manufacturer
Michigan Carbon Works, Detroit, Mich.	Dessicated Bone	Manufacturer
Joseph Lister, Chicago, Ill	Pure Bone Meal	C. H. Farnum, Benton Harbor C. B. Waterloo, Port Huron
James Boland, Jackson, Mich.	Blackman Fertilizer	Manufacturer
Detroit Sanitary Works, Detroit, Mich.	Superior Potato Manure	W. A. Walters, Battle Creek J. W. Kandt, Utica
Detroit Sanitary Works, Detroit, Mich.	Clover Leaf Fertilizer	W. P. Darling, Kalamazoo E. J. Miller, Washington
Crocker Chemical Co., Buffalo, N. Y.	Pure Ground Bone	Manufacturer
Crocker Chemical Co., Buffalo, N. Y.	Ammoniated Wheat and Corn Superphosphate	Seth Lathrop, Richmond
Crocker Chemical Co., Buffalo, N. Y.	Vegetable Bone Superphosphate	Guy Kimball, Port Huron
Crocker Chemical Co., Buffalo, N. Y.	Ground Bone Meal	Manufacturer
Crocker Chemical Co., Buffalo, N. Y.	Ammoniated Practical Superphosphate	T. F. Chilson, Plymouth

in Michigan for 1895.

	Available nitrogen. Estimated as ammonia.	Phosphoric Acid. Available P_2O_5.	Phosphoric Acid. Insoluble P_2O_5.	Phosphoric Acid. Total P_2O_5.	Potash Soluble in Water. Estimated as K_2O.	Potash Soluble in Water. Estimated as K_2SO_4.
Claimed Found	1 2.07	1 13.28	---------- .56	1 13.84	1 .96	1 1.78
Claimed Found	2.25 to 3.15 2.84	8 to 11 10.48	.5 to 1.5 .84	8.5 to 12.5 11.32	1.5 to 2 1.67	---------- 3.09
Claimed Found	1.25 to 2 1.31	8 to 9 8.04	2 to 3 1.39	10 to 12 9.43	---------- ----------	---------- ----------
Claimed Found	1.94 to 2.68 2.55	8.5 to 10 9.23	.5 to 1.5 1.06	9 to 11.5 10.29	5 to 6 4.25	---------- 7.86
Claimed Found	4.6 to 5.35 6.54	5 to 6.5 7.26	---------- .73	---------- 7.99	6.5 to 7.5 7.63	---------- 14.11
Claimed Found	.8 to 1.25 1.36	10 to 11 11.86	1 to 2 .95	11 to 13 12.31	7 to 8.5 6.38	---------- 12.80
Claimed Found	---------- ----------	28 to 32 30.94	---------- 1.2	32 to 36 32.14	---------- ----------	---------- ----------
Claimed Found	1.5 to 2.5 2.84	---------- ----------	---------- ----------	25 to 30 29.42	---------- ----------	---------- ----------
Claimed Found	3.05 4.59	---------- ----------	---------- ----------	24.65 24.81	---------- ----------	---------- ----------
Claimed Found	1 1.10	3. 4.69	3 1.32	---------- 6.01	.50 .25	---------- .46
Claimed Found	3.5 to 4.2 4.13	5 to 7 6.26	2 to 3 1.24	7 to 10 7.51	4 to 5 4.93	---------- 9.12
Claimed Found	2.25 to 3.25 2.82	6 to 8 8.23	2 to 3 1.68	8 to 11 9.91	2 to 3 2.48	---------- 4.49
Claimed Found	3.5 to 4.5 4.95	---------- ----------	---------- ----------	25 24.94	---------- ----------	---------- ----------
Claimed Found	2.5 to 3.5 2.50	10 to 13 10.24	1 to 2 1.78	11 to 15 12.02	1.60 to 2.70 1.75	3 to 5 3.24
Claimed Found	6 to 7 6.81	6 to 7 7.13	1 to 2 1.34	7 to 9 8.47	5.94 to 8 7.10	11 to 15 13.18
Claimed Found	2.5 to 4 3.4	---------- ----------	---------- ----------	25 to 28 26.57	---------- ----------	---------- ----------
Claimed Found	1 to 2 1.27	8 to 10 8.79	1 to 2 .70	9 to 12 9.49	1.08 to 2 1.21	2 to 3 2.23

Analysis of commercial fertilizers

Manufacturer.	Trade name.	Dealer and locality.
Crocker Chemical Co., Buffalo, N. Y.	Ammoniated Bone Superphosphate	Seth Lathrop, Richmond
Crocker Chemical Co., Buffalo, N. Y.	Superphosphate No. 2.	Manufacturer
Crocker Chemical Co., Buffalo, N. Y.	New Rival Ammoniated Superphosphate	T. F. Chilson, Plymouth
Crocker Chemical Co., Buffalo, N. Y.	Special Potato Manure	Seth Lathrop, Richmond
Crocker Chemical Co., Buffalo, N. Y.	Niagara Phosphate	Manufacturer
Crocker Chemical Co., Buffalo, N. Y.	Potato, Hop and Tobacco Phosphate	Seth Lathrop, Richmond
American Plant Food Co., Richmond, Va.	Pamunky Phosphate	Manufacturer
Jarecki Chemical Co., Sandusky, Ohio	Lake Erie Fish Guano	H. C. Hill, Petersburg
Jarecki Chemical Co., Sandusky, Ohio	Fish and Potash Potato and Tobacco Food	H. C. Hill, Petersburg
Jarecki Chemical Co., Sandusky, Ohio	C. O. D. Phosphate	Manufacturer
Jarecki Chemical Co., Sandusky, Ohio	Pure Ground Bone	Manufacturer
H. J. Baker & Bros., New York	Vegetable and Vine Fertilizer	Alfred Brown, Grand Rapids
S. M. Isbell & Co., Jackson, Mich.	Isbell's Celery Grower	Manufacturer
S. M. Isbell & Co., Jackson, Mich.	Isbell's Vegetable Fertilizer	Manufacturer
Armour & Co., Chicago, Ill.	Armour's Bone, Blood and Potash	Stevens & Morton Co., Benton Harbor
Armour & Co., Chicago, Ill.	Armour's Ammoniated Bone and Potash	Seth Lathrop, Richmond J. Switzer, Washington
Armour & Co., Chicago, Ill.	Armour's Pure Bone Meal	Stevens & Morton Co., Benton Harbor

in Michigan for 1895.—CONTINUED.

	Available nitrogen.	Phosphoric acid.			Potash soluble in water.	
	Estimated as ammonia.	Available P_2O_5.	Insoluble P_2O_5.	Total P_2O_5.	Estimated as K_2O.	Estimated as K_2SO_4.
Claimed	3.5 to 4.5	10 to 12	1 to 2	11 to 14	1.05 to 2	2 to 3
Found	3.5	8.68	2.35	11.03	1.22	2.25
Claimed	....	11 to 13	1 to 2	12 to 15	1.35 to 2	2.5 to 3.5
Found	....	11.69	4.04	15.73	1.64	3.02
Claimed	1.5 to 2.5	10 to 12	1 to 3	11 to 15	1.6 to 3	3 to 5
Found	1.48	10.11	2.30	12.41	1.58	2.90
Claimed	4.5 to 5.5	8 to 9	1 to 2	9 to 11	5.4 to 6.4	10 to 12
Found	4.81	8.25	1.66	9.91	5.43	10.03
Claimed	....	11.5 to 13	1 to 3	12.5 to 16	....	....
Found	....	11.87	4.23	15.6	....	....
Claimed	2.5 to 3.5	10 to 12	1 to 2	11 to 14	3.25 to 4.3	6 to 8
Found	2.44	10.18	2.45	12.63	3.70	6.85
Claimed	....	6 to 7	6 to 7	12 to 14	....	....
Found	....	2.87	8.80	11.67	....	....
Claimed	2 to 3	10 to 12	1.5 to 2	11.5 to 14	1 to 2	....
Found	1.27	9.33	5.7	15.08	1.5	2.78
Claimed	2 to 3	6 to 7	1 to 2	7 to 9	3.5 to 4	....
Found	1.27	10.53	2.7	13.23	4.91	9.08
Claimed	....	14 to 15	1 to 2	15 to 17	....	....
Found	....	16.49	2.11	19.6	....	....
Claimed	4 to 5	....	....	20 to 21	....	....
Found	6.06	....	....	20.3	....	....
Claimed	3 to 6	5 to 8	....	....	7 to 10	....
Found	4.72	7.51	1.28	8.79	8.97	16.79
Claimed	2.5 to 3.5	....	....	10 to 12	10 to 12	....
Found	2.33	....	....	20.65	11.2	20.72
Claimed	4 to 5	7 to 9	....	....	6 to 7	....
Found	4.50	9.69	.95	10.64	7.99	14.78
Claimed	4 to 4.75	8 to 10	4 to 6	12 to 16	6.5 to 8.5	....
Found	4.76	10.81	2.97	13.78	7.01	12.97
Claimed	2.2 to 2.80	8	2.75 to 3.75	10.75	1 to 2	....
Found	3.06	7.53	2.7	10.33	1.4	2.59
Claimed	2.5 to 3.3	....	....	25 to 29	....	....
Found	3.09	....	....	24.43	....	....

Analysis of commercial fertilizers

Manufacturer.	Trade name.	Dealer and locality.
Armour & Co., Chicago, Ill.	All Solube	Seth Lathrop, Richmond
Armour & Co., Chicago, Ill.	Armour's Raw Bone Meal	Pomeroy Implement Co., South Haven
Armour & Co., Chicago, Ill.	Armour's Bone and Blood	Seth Lathrop, Richmond
Northwestern Fertilizing Co., Chicago, Ill.	Celery Grower	Manufacturer
Northwestern Fertilizing Co., Chicago, Ill.	Fine Raw Bone	Ainsworth & Bachelder, Ypsilanti
Northwestern Fertilizing Co., Chicago, Ill	Potato Grower	Peter Grinnell, Richmond
Northwestern Fertilizing Co., Chicago, Ill.	Garden City Superphosphate	Stevens & Morton Co., Benton Harbor
Northwestern Fertilizing Co., Chicago, Ill.	Prairie Phosphate	Ainsworth & Bachelder, Ypsilanti
Northwestern Fertilizing Co., Chicago, Ill.	Challenge Corn Grower	Ainsworth & Bachelder, Ypsilanti
Northwestern Fertilizing Co., Chicago, Ill.	Ground Bone	Ainsworth & Bachelder, Ypsilanti
Speidel, Swartz & Fisher, Grand Haven, Mich.	Celery Hustler	N. Robbins, Jr., Grand Haven
Niagara Fertilizer Co., Buffalo, N. Y.	Wheat and Corn Producer	C. E. Lockwood, Washington
Niagara Fertilizer Co., Buffalo, N. Y.	Niagara Grain Grower	Manufacturer
Niagara Fertilizer Co., Buffalo, N. Y.	Niagara Triumph	Manufacturer
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern Potato Manure	Pomeroy Implement Co., South Haven
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern Corn Fertilizer	Gill R. Lovejoy, Lenox
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern English Wheat Grower	Manufacturer

in Michigan for 1895.—CONTINUED.

	Available nitrogen.	Phosphoric acid.			Potash soluble in water.	
	Estimated as ammonia.	Available P_2O_5.	Insoluble P_2O_5.	Total P_2O_5.	Estimated as K_2O.	Estimated as K_2SO_4.
Claimed	2.7 to 3.7	8 to 10	3 to 4	11 to 14	4 to 5	....
Found	4.09	10.04	3.32	13.36	5.06	9.36
Claimed	3.8 to 4.5	....	13 to 15	24.47	....	....
Found	4.67	....	14.39	23.28	....	....
Claimed	5.31 to 6.51	7.25 to 8.25	4 to 7	11.25 to 15.25	....	....
Found	6.42	8.12	6.84	14.96	....	....
Claimed	3 to 4	7 to 9	....	....	....	4 to 5
Found	3.86	7.49	3.86	11.35	1.73	3.21
Claimed	4 to 5	....	....	22 to 24	....	....
Found	4.79	....	....	21.93	....	....
Claimed	3 to 4	7 to 9	....	....	....	4 to 5
Found	2.89	7.33	4.08	11.41	2.47	4.63
Claimed	2.5 to 3	8 to 9	4 to 4.5	12 to 13.5	.54 to 1.08	....
Found	3.26	9.23	3.39	13.62	.77	1.43
Claimed	2 to 2.5	6 to 8	3 to 4	9 to 12	....	....
Found	2.31	7.35	4.41	11.76	....	....
Claimed	2.5 to 3.5	8 to 9	....	....	....	.1 to 2
Found	2.97	7.99	3.90	11.89	.85	1.57
Claimed	3 to 4	....	....	18 to 22	....	....
Found	4.42	....	....	22.06	....	....
Claimed	....	....	....	....	....	....
Found	7.90	2.93	.74	3.67	1.1	2.03
Claimed	....	....	....	....	....	....
Found	1.63	7.55	4.92	12.47	.18	.33
Claimed	....	....	....	....	....	....
Found	1.12	8.05	2.23	10.23	1.31	2.43
Claimed	....	....	....	....	....	....
Found	3.26	9.17	1.33	11.00	2.57	4.65
Claimed	2 to 3	8 to 10	1 to 3	9 to 13	3.25 to 4	....
Found	2.17	9.08	.41	9.49	5.1	9.51
Claimed	.8 to 1.5	8 to 10	1 to 3	9 to 13	4 to 6	....
Found	2.43	8.79	.35	9.14	6.55	12.11
Claimed	.88 to 1.76	8 to 12	1 to 3	9 to 15	2 to 4	....
Found	1.46	7.07	2.3	9.37	3.69	6.83

Analysis of commercial fertilizers

Manufacturer.	Trade name.	Dealer and locality.
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern Dissolved Bone Fertilizer	Manufacturer
Milson Rendering and Fertilizer Co., Buffalo, N. Y.	Potato, Tobacco and Hop Phosphate	W. M. Cahon, Reading
Milson Rendering and Fertilizer Co., Buffalo, N. Y.	Buffalo Fertilizer	W. M. Cahon, Reading
Milson Rendering and Fertilizer Co., Buffalo, N. Y.	Vegetable Bone Fertilizer	W. M. Cahon, Reading
Milson Rendering and Fertilizer Co., Buffalo, N. Y.	Cyclone Bone	Rouget & Miller, Palmyra
Milson Rendering and Fertilizer Co., Buffalo, N. Y.	Wheat, Oats and Barley Phosphate	W. M. Cahon, Reading
Lister's Agricultural Chemical Works, Newark, N. J.	Lister's Special Potato Fertilizer	P. P. Andrews, Washington
Lister's Agricultural Chemical Works, Newark, N. J.	Lister's Success	P. P. Andrews, Washington
W. S. Dunbar, St. Joseph, Mich.	Meat and Bone Fertilizer	Manufacturer

in Michigan for 1895.—CONCLUDED.

	Available nirtogen.	Phosphoric acid.			Potash soluble in water.	
	Estimated as ammonia.	Available P_2O_5.	Insoluble P_2O_5.	Total P_2O_5.	Estimated as K_2O.	Estimated as K_2SO_4.
Claimed	----------	13 to 15	----------	----------	----------	----------
Found	----------	17.14	.77	17.91	----------	----------
Claimed	2.5 to 4	8 to 11	1 to 2	9 to 13	4 to 6	----------
Found	2.55	8.58	1.65	10.23	3.69	6.83
Claimed	2.25 to 4	9 to 12	1 to 3	10 to 15	1.5 to 2.5	----------
Found	2.83	6.89	2.7	9.59	1.55	2.85
Claimed	5 to 6	8 to 10	1 to 2	9 to 12	5 to 6	----------
Found	6.08	7.29	.38	7.67	5.27	9.69
Claimed	3 to 4	----------	22 to 25	22 to 25	----------	----------
Found	4.08	----------	25.81	25.81	----------	----------
Claimed	1.5 to 4	9 to 10	1 to 3	10 to 13	2 to 3	----------
Found	1.70	7.19	2.56	9.75	2.09	3.85
Claimed	2 to 3	8 to 10	----------	----------	3 to 4	----------
Found	2.04	8.61	2.58	11.19	1.81	3.33
Claimed	1.50 to 2	9.50 to 11	----------	----------	2 to 3	----------
Found	1.95	9.51	2.67	12.18	2.27	4.18
Claimed	----------	----------	----------	----------	----------	----------
Found	6.20	4.47	4.16	8.63	.18	.33

The following fertilizers have not been licensed for 1895. The penalty for selling without license is $100 for first offense, and $300 for each subsequent offense. See section 6 of Act No. 26, of session laws of 1885, printed in this Bulletin.

Manufacturer.	Trade Name.	Dealer and Locality.
Michigan Carbon Works, Detroit Mich	Lawn Fertilizer	O. A. Thompson & Son, Ypsilanti
Grand Rapids Glue Co., Grand Rapids, Mich.	Non Plus Ultra	Perkens & Hess, Grand Grand Rapids
Van De Venter, Dundee Mich.		Manufacturer
Cleveland Dryer Co., Cleveland, Ohio	Ohio Seed Maker	L. B. Spencer, Holloway
Cincinnati Desiccating Co., Cincinnati, Ohio	Gilead Phosphate	John Wallace, St. Joseph
Cincinnati Desiccating Co., Cincinnati, Ohio	Complete Garden Truck Manure	John Wallace, St. Joseph
Cincinnati Desiccating Co., Cincinnati, Ohio	Ohio Valley Phosphate	John Wallace, St. Joseph
Cincinnati Desiccating Co., Cincinnati, Ohio	Phœnix Phosphate	John Wallace, St. Joseph
Cincinnati Desiccating Co., Cincinnati, Ohio	Fine Ground Bone	John Wallace, St. Joseph
Swift & Co., Chicago, Ill.	Tankage	C. B. Waterloo, Port Huron
Swift & Co., Chicago, Ill.	Ground Steamed Bone	C. B. Waterloo, Port Huron
Armour & Co., Chicago., Ill.	High Grade Dissolved Bone	Pomeroy Implement Co., South Haven
Fitch Fertilizer Works, Bay City, Mich	Big Crop Phosphate	Manufacturer
Fitch Fertilizer Works, Bay City, Mich	Pure Bone Meal	Manufacturer
W. S. Dunbar, St. Joseph, Mich.	Fish Guano	Manufacturer

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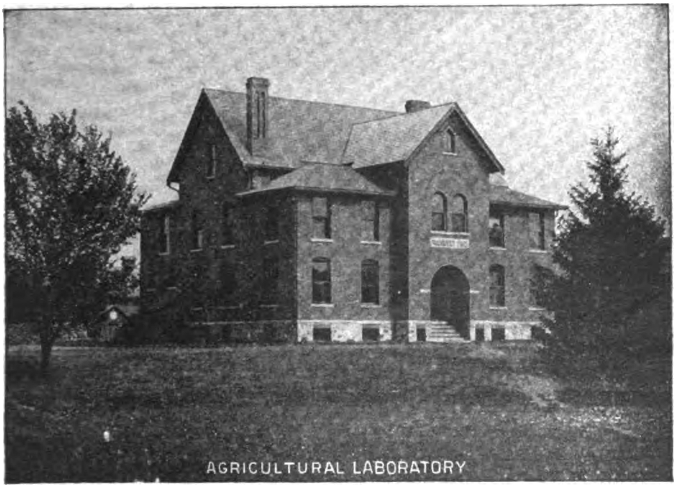
MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

FARM DEPARTMENT



127. DAIRY RECORDS
128. FATTENING LAMBS

AGRICULTURAL COLLEGE, MICHIGAN
1895

BACK NUMBERS OF BULLETINS.

Copies of the following Station Bulletins only are still on hand and will be sent to farmers free while they last, on application.

No. 65. Planting for Honey.
67. Fruit Tests at South Haven Station.
68. The Jack-pine Plains.
69. Feeding Steers of Different Breeds.
71. Beet Sugar.
77. Comparing the Yield of Old Meadows with those Recently Planted.
78. Glanders and Farcy.
79. Vegetable Tests.
93. Potatoes.
98. Locusts and the Horn Fly.
103–6. (In one volume.) Peach and Plum Culture. A Year Among Fruits. Michigan Fruit List. Strawberries and Raspberries.
113–16. (In one volume.) Fattening Lambs. Rape as a Forage Plant. Management of Swamp Lands. Insects in the Clover Field.
118. Fruits at South Haven.
119–20. Potatoes—Vegetable Novelties and Notions.
121. Pests of the Orchard and Garden.
122–24. Small Fruit Notes. Native Plums and Cherries. The Apple Orchard.

I. H. BUTTERFIELD,
Secretary.

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MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

FARM DEPARTMENT

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127 Dairy Records

128 Fattening Lambs

BY CLINTON D. SMITH AND F. B. MUMFORD,

AGRICULTURAL COLLEGE, MICH.
1895

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

MICHIGAN AGRICULTURAL EXPERIMENT STATION.

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Railroad and Express Address, ...	Lansing, Mich.

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SUB-STATIONS.

Grayling, Crawford County, 80 acres deeded.
South Haven Van Buren County, 10 acres rented; 5 acres deeded.

BULLETIN NO. 127. **SEPTEMBER, 1895.**

DAIRY RECORDS.

BY CLINTON D. SMITH.

The method of keeping the records of the college herd is as follows:

The cows are milked into tin pails of uniform weight, and each mess is weighed on a Chatillon spring balance, graduated to tenths of a pound. The balance is provided with two index fingers, one of which is so adjusted as to stand at zero when the empty pail in which the milking is to be done is hanging on the hook. This finger then points to the exact weight of the mess as the cows are subsequently milked, and the necessity of subtracting the weight of the pail for each milking is avoided. A chart hangs on the wall of the separator room on which at the left in a vertical column are printed consecutive numbers from one to thirty-one, to correspond with the days of the month, two horizontal lines being allowed for each day, the one for the morning mess, the other for the evening. The names of the cows are written at the top of the sheet over the vertical columns from left to right in the order in which they are milked. As soon as the given mess is weighed, the weight is set down under the name of the cow which yielded it, and opposite the proper date. On page 4 is shown part of a monthly milk record.

The advantages of keeping a record of this kind cannot be overestimated. A glance at the milk sheet shows not only which cows are giving the largest yields but the variations in yield of all the cows. A sudden shrinkage, the symptom of some derangement of the system, which would pass unnoticed if no continuous record is kept is called to the attention of the milker as soon as he looks at the milk sheet to set down the weight of the first decreased mess. The cause of the shrinkage is investigated and removed and the ounce of prevention often saves the pound of cure. It induces regularity and cleanness of milking; the milker soon learns the yield of each particular cow, and his interest being aroused by his definite knowledge, he almost unconsciously strives to keep up the flow.

The effect of any change of food is exhibited most often in the amount of the milk yield, rather than in its quality. Whenever, therefore, it is necessary to alter the ration of the cows for any reason, the chart shows the increase or decrease in the yield and the profit or loss from the change may be estimated.

Michigan Agricultural College, Milk Record for month of May, 1894.

Day.		Anze Neptune.	Oatka.	Aaggie.	Rosa Bonheur.	Rosa Bonheur (night).	Houwtje D.	Houwtje D. (night).	Rhea.	Belle Sarcastic.	Belle Sarcastic (night).	College Houwtje.	Susie Stewart.
1	a. m.	14.2	10.9	9.1	28.7	......	16.5	......	18.7	22.6	......	13.8	15.4
	p. m.	13.3	10.6	8.4	28.1	22.4	17.4	17.9	18.1	22.2	20.9	13.1	13
2	a. m.	15.6	11.3	9.2	27.2	......	24.2	......	19.4	25.4	......	13.6	15.1
	p. m.	13.1	10.3	7.6	22.8	24.4	23.2	20.7	18.2	23 5	20.5	12.4	13.5
3	a. m.	17.1	12.4	10.6	25.7	......	24.5	......	20.9	25.1	......	15.2	15.7
	p. m.	15	12	10	24.7	23.3	25.1	22.9	21.9	23.5	21.1	11.5	11.9
4	a. m.	17	12.2	9.5	27	......	27.1	......	21.5	26.3	......	13.7	16.3
	p. m.	14.1	11.4	7.7	26.3	22.9	27.4	25.1	18.9	22.6	23.3	11.3	12.1
5	a. m.	16.3	12.9	9.7	27.2	......	27 8	......	20.1	25.4	......	14.3	14.8
	p. m.	14.2	11	8.1	26.2	23.8	26.1	27.3	16.8	25.4	23.4	13.6	13.1
6	a. m.	16.1	12.4	9.8	26.8	......	29	......	19	27.4	......	14.7	13
	p. m.	13.1	10.1	7.5	26.8	21.9	28.7	25.5	16.1	23.2	20.7	12.5	13.1
7	a. m.	16.2	11.4	9.4	29.5	......	29.8	......	19	27	......	15.3	14.5
	p. m.	13.7	11.1	8.1	26.8	24.6	29	27.1	17.4	24.7	23.1	13.2	12.2
8	a. m.	15	11	9	26.3	......	31.7	......	18.4	26.5	......	14.6	14.4
	p. m.	13	10.5	7.6	24.7	21.1	26.6	23.3	17	24.3	22.4	13	11.5
9	a. m.	16.5	12.2	8.6	26.3	......	30.4	......	21	25.4	......	14.9	14.3
	p. m.	13.5	11.1	......	24.5	23.7	30.5	23.4	17.4	23.2	22.9	13.8	12.1
10	a. m.	14.5	11.7	13	27	......	29.3	......	19	26.4	......	14.2	14.2
	p. m.	13.1	10.7	......	27.7	24.7	29.9	29.9	17	25.5	23	13.5	13.6
11	a. m.	15.9	9.2	12.1	26.1	......	28.3	......	18.3	26.2	......	15.8	13.3
	p. m.	13.9	10.7	......	24.5	24.3	29	28.2	17.3	24.9	24.5	13.2	11.7
12	a. m.	15.4	11.3	10.2	27.4	......	32.2	......	18.2	27.1	......	14.2	13.8
	p. m.	13.8	8.0	......	25.4	22.7	29.8	27.7	18	24.7	24	13.6	14.2
13	a. m.	15.3	11.5	10.4	25.2	......	30	......	17.4	28.8	......	13.6	13
	p. m.	12.4	10.2	......	23.2	18.3	30	30	16	24.5	23.7	12.3	10.3
14	a. m.	14.7	12.1	9.3	22.9	......	30	......	19.5	28	......	14.7	13
	p. m.	12	10.8	......	21.1	18.5	30.5	26.5	16	23.5	26.1	13.2	11.8
15	a. m.	13.6	10.8	9.7	24	......	29.5	......	16.8	27.9	......	14.2	12.1
	p. m.	12.8	10.6	......	24.7	23.4	30	28.8	16.5	26.7	25.5	13.2	9.7
16	a. m.	14	11.1	8.6	26.1	......	31	......	20.2	28.7	......	13.5	13.1
	p. m.	12	10.3	......	24	21	29.5	30	19.6	26.9	25.2	12.9	10.7
17	a. m.	15	12	8.4	25.1	......	31.6	......	18.8	28	......	14.9	11.7
	p. m.	8.4	11	......	24.8	22.6	31.4	29.1	17.3	25.2	24.8	13.6	10
18	a. m.	13.1	10.1	8.9	25.1	......	30	......	16.9	28.7	......	14.6	13
	p. m.	13.8	10.3	......	22.6	23.3	28.2	29.8	16.6	24	24.8	12.5	10.2
19	a. m.	14.5	11.1	8.1	26.4	......	30.7	......	19	29.8	......	14.8	13
	p. m.	12	8.8	......	24.8	22.2	31.2	28.9	16.8	26.4	25.3	12.9	9.5
20	a. m.	14	8.7	7.4	27.8	......	31.2	......	17.8	28.3	......	15.2	13
	p. m.	12	11.5	......	28.8	23.2	28.4	29.4	16.1	25	23.5	13.1	9.2
21	a. m.	12.8	9	6.3	26.1	......	30.6	......	16.9	27.6	......	15	11.7
	p. m.	11.6	8.4	......	23.2	22	28.2	28.6	16	23.2	24	13.3	8
22	a. m.	13	12.2	......	25.8	......	30.3	......	16.1	26.6	......	13.6	9.5
	p. m.	10.8	9.3	......	22	22.5	32.2	27.9	17.2	24.4	24.6	14.3	8.5
23	a. m.	12.1	9.9	......	25.3	......	27.8	......	17.7	31.2	......	14	11.5
	p. m.	11.2	9.8	......	22.6	21.6	30.6	28	16.9	23.7	24.3	13.8	9.3
24	a. m.	13.4	10.1	......	25.9	......	29.3	......	17.9	29.6	......	14.6	13
	p. m.	11.7	9.3	......	25.8	22.1	31.4	31.8	16.1	26.1	26.4	13	10.1
25	a. m.	12.8	10	......	25.2	......	27.1	......	18	29.4	......	14	11
	p. m.	10.4	9.7	......	23.1	23.8	29.1	29.8	15.6	26.1	24.7	13.4	10.1
26	a. m.	12.6	11.1	......	27.8	......	30.3	......	19.1	29.3	......	15.7	11.5
	p. m.	11.1	9.9	......	26.1	20.8	29.2	25.8	15.9	26.4	22.9	13.3	10.7
27	a. m.	14.4	5.7	......	30.7	......	34.1	......	18.6	30.7	......	16	11.7
	p. m.	12.4	8.5	......	22.5	21.7	26.6	24.7	13.1	24.1	24.7	11.2	10.9
28	a. m.	14.7	10.5	......	27.6	......	33.3	......	17.9	28	......	14.9	9.9
	p. m.	12.7	10	......	24.5	19.5	22.8	24.2	15.7	25.5	23.9	13.4	9.2
29	a. m.	14.2	11.2	......	29.3	......	27.9	......	17	27.3	......	14.9	11.7
	p. m.	12.6	9.9	......	25.7	22.4	24.3	27.8	16.1	24.9	23.1	13.8	9.5
30	a. m.	15.7	11.5	......	29.8	......	28	......	19.3	28.8	......	15.4	11.3
	p. m.	13.3	10.4	......	24	23.4	26.6	30.4	16.3	25	24.5	13.3	10.6
31	a. m.	14.8	10.2	......	24.9	......	24	......	17.2	25.4	......	15.1	11.5
	p. m.	13.1	9.9	......	22.3	22	26.7	28.1	15	26.1	24.6	12.7	10

The milk sheet will show, moreover, the decrease in the quantity of the yield of the herd induced by exposure to cold rains or to other bad conditions. Without the record this loss will exist but is unknown. The

record simply calls it to the attention of the dairyman and emphasizes the advantage of taking good care of the cow.

As soon as the mess is weighed, a sample is taken for testing or for analysis at the chemical laboratory by means of a milk thief. This milk thief consists of a hollow tin or copper tube about three-eighths of an inch in diameter and twenty inches long, to the side of which, near one end, is soldered a wire handle large enough to permit the entrance of three fingers. Where the diameter of this tube exceeds three-eighths of an inch, the bottom end should be slightly drawn in, making the aperture not over a quarter inch in diameter. In taking the sample for testing or analysis, the tube is slowly sunk into the mess as soon as it is removed from the weighing balances, until the lower end reaches the bottom of the pail; the tube is thus allowed to fill with the milk as it sinks. The thumb is then placed over the upper end of the tube, retaining in it the milk which it contains. The latter is then allowed to flow into a fruit jar provided with a tight cover. On the side of this jar is indelibly printed the name of the cow which yielded the milk from which the given sample was taken. At the completion of the milking of the herd, the samples thus taken are either removed to the dairy house where they are tested, or remain on the shelves to become part of the composite test as described later. The records of the three cows, Rosa Bonheur, Houwtje D., and Belle Sarcastic, are made up by weighing the milk as here described, and testing separately, and in duplicate, each milking. Whenever the duplicate tests have varied perceptibly, they were discarded and new tests made. By this method all the necessary facts are furnished for accurately determining both the quantity of milk and the quantity of butterfat secreted at each milking of every day during the milking period.

When not connected with some specific experiment, wherein the variation in richness of milk from one milking to another is of importance, the samples of milk of the other cows are treated differently. By means of the milk thief the samples are taken from the original milking and placed in fruit jars as described above. Instead, however, of testing each sample by itself, successive samples for several days are allowed to accumulate in the fruit jar. At the beginning of the week in the empty fruit can, there is placed a small quantity, about the size of a pea, of a mixture of two chemicals to keep the milk from souring and curdling. These chemicals are bichromate of potash and corrosive sublimate, mixed in the proportion of three of the former to one of the latter. *These chemicals are dangerous poisons and must be handled accordingly.* As often as a cow is milked, the sample taken by the milk thief is put in the can bearing her name and the contents well shaken. At the end of the week, if the cow is milked twice per day, the can will contain the mixed samples of fourteen messes. and will accurately represent all the milk she has given during the week as to richness in butterfat. This composite sample, as it is called, is then taken to the laboratory for testing. In extremely hot weather in summer it may be necessary to test twice a week, but in the cool weather of fall and spring and during the winter, once a week is amply sufficient.

To determine the amount of butterfat yielded by the cow during the week, it is necessary simply to add together the pounds of milk yielded at the different milkings, and multiply the sum by the per cent of fat indicated by the test of the composite sample.

BABCOCK TEST.

Since the records of butterfat reported in this bulletin are made by the use of the Babcock test, a description of the apparatus and the method of operating it can not be omitted.

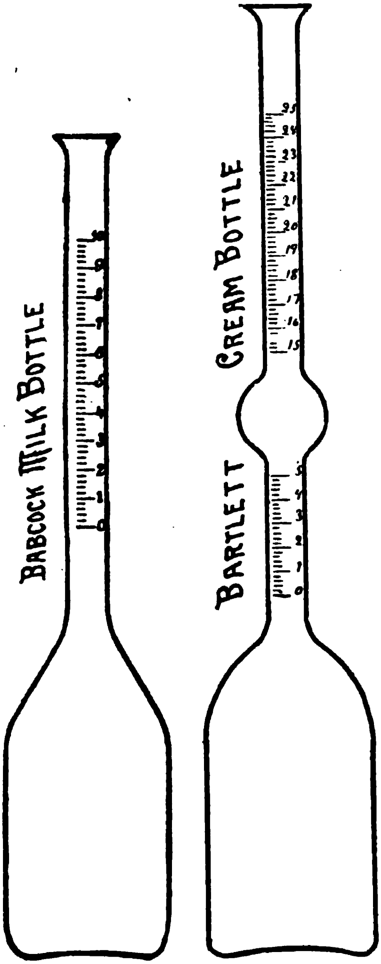


FIG. 1.

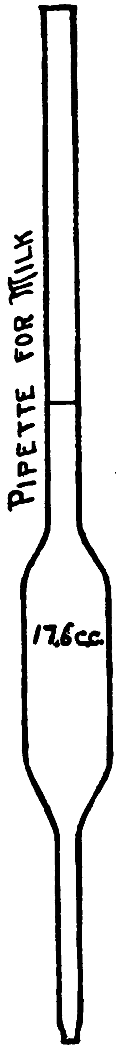


FIG. 2.

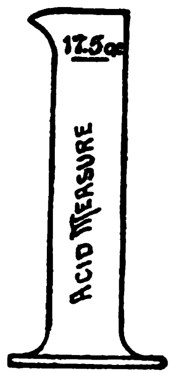
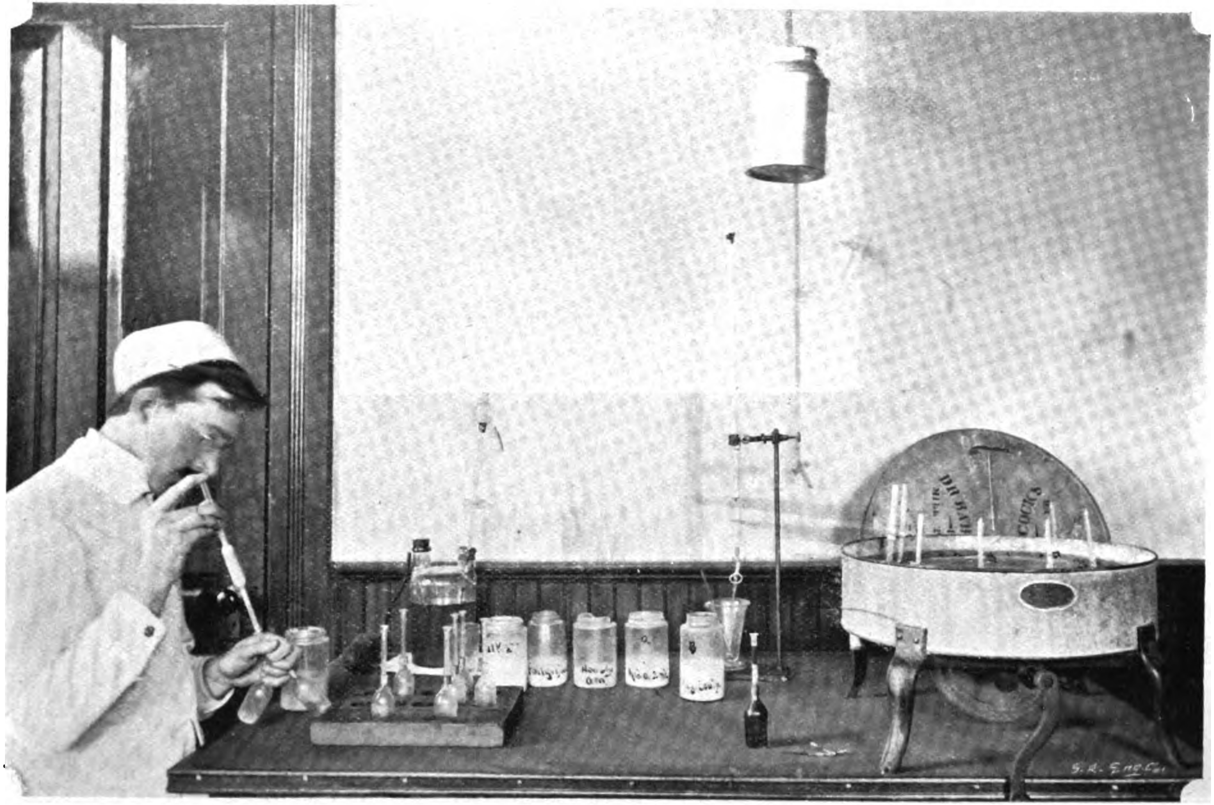


FIG. 3.

Apparatus and Chemicals.—The test here described was the invention of Dr. S. M. Babcock, of the Experiment Station of the University of Wisconsin. The test bottles used are shown in Fig. 1. They are made of heavy glass and should have a capacity up to the neck of not less than forty cubic centimeters. The graduation on the neck extends from zero to ten per cent. The division on the necks of the bottles should be uniform and the lines should be parallel. These lines should be black-



TESTING OUTFIT.

ened to be easily read. If by use and washing the black disappears from the lines, it may be restored either by a lead pencil or by rubbing with black ink or other dark compound.

Care should be taken in purchasing the bottles to secure them from reliable parties. They should be made of strong glass, and the graduation must be correctly made. It is well to avoid cheap bottles.

Pipette for Measuring Milk.—This pipette, Fig. 2, should hold 17.6 c. c. when filled to the mark upon its neck. The opening in the lower end of the pipette should be large enough to allow the milk to flow out rapidly and the upper end should be square across and not bell shaped. It is absolutely essential that the pipette should contain exactly the required amount of milk. The dairyman should purchase it of a reliable firm as a guaranty of its accuracy.

Fig. 4.

Fig. 5.

The acid is measured usually by means of a small glass cylinder shown in Fig. 3, holding 17.5 c. c. Simple and rapid measures of improved pattern are now offered at prices which put them within the reach of owners of large dairies. One form is shown in Fig. 4.

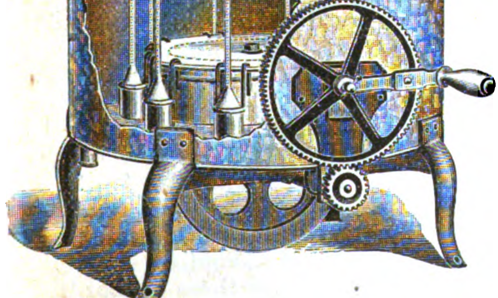


Fig. 6.

Two of the many different styles of the centrifugal machine in which the bottles are revolved are shown in Figs. 5 and 6. It is essential that the bottles be made to revolve at sufficient speed. If the horizontal wheel to the periphery of which the pockets holding the bottles are attached is less than 15 inches in diameter, it should be made to revolve at 1,000 revolutions per minute; if the wheel is 20 inches in diameter the number of revolutions may be reduced to 700 per minute. When purchasing a hand machine, it is better to secure one driven by cog-gear rather than by friction; a given

number of turns of the handle will then invariably secure a definite number of revolutions of the bottles. In machines driven by friction there is apt to be a loss from slipping large enough to reduce the revolutions of the bottles below the speed required. Where the machine is driven by a belt, great care must be taken to have the belt tight enough to drive the machine at the requisite speed.

In the purchase of a power machine for a factory, see to it that the vertical shaft to which the wheel containing the bottles is attached, is made to project through the cover far enough to permit the use of a speed indicator, or some arrangement provided whereby the speed may be determined. The low readings of fat in some creameries is undoubtedly due to the fact that the machines are not driven fast enough to bring all the fat to the surface and into the necks of the bottles. The pockets holding the bottles when revolving, should be in the plane of the wheel and not in boxes soldered on the sides of pieces of zinc or tin, as the centrifugal force is very apt to break the soldering and destroy the bottle.

The acid used is the ordinary commercial oil of vitriol, or sulphuric acid having a specific gravity of 1.82. If the acid is too weak it will not dissolve all of the curd and a cheesy substance will be so far mixed with the fat in the neck of the bottle as to render correct reading impossible. If the acid is too strong it will blacken the fat and leave a charcoal-like substance floating with the fat in the neck of the tube, rendering correct reading equally impossible. If the acid is slightly too weak, that difficulty may be overcome by using a little more of it. If but little too strong, blackening may be partially avoided by using slightly less acid, or by having the milk and the acid both cold when mixed. Sulphuric acid has a great avidity for water, and must be kept in a tightly stoppered bottle, the stopper being either of glass or rubber, as a common cork is soon destroyed. The dairyman with but a small herd of cows can obtain sufficient acid of the local druggist at a low price; the factory may purchase it at wholesale in carboys at a price still lower. The carboy should be kept in the original wooden box in which it is received and as tightly covered as possible. *The acid is very corroding, and must be handled with extreme care.*

METHOD OF OPERATION.

Since the quantity of milk placed in the test bottle is small, it is essential that it should accurately represent the whole of the milk to be tested. If milk is allowed to stand, even for a short time, the fat begins to rise and a sample taken from the upper part of the milk will necessarily be richer in fat than one taken from the bottom, and neither sample will fairly represent the average quality of the entire mess. In taking the original sample, therefore, either mix the milk thoroughly by stirring it with a long handled dipper or use the milk thief as already described.

Before measuring the milk with the pipette into the test bottle, it is necessary to have the sample of milk again well shaken. If the samples have stood for any length of time, it is well to have an extra fruit can, and after agitating the milk in the can in which it was originally placed, by shaking with a horizontal motion, pour it into another can held at such an angle that the milk will flow down its side, avoiding the admixture of bubbles of air; pour back and forth in this way three or four times until the clots of cream have become completely mingled with the mass of the milk. Where the bichromate of potash and corrosive sublimate have been used in the composite sample, the milk will be of a yellow color

and less difficulty will be experienced with the rise of the cream. It must be well stirred, however, and where possible, poured from one can to another, at least twice, taking care to allow the milk to flow down the side of the bottle. Loppered milk or milk with a thick, leathery cream cannot be satisfactorily tested.

In partial answer to the question whether a correct test of milk could be made by taking the sample with the pipette directly from the mess as soon as drawn from the udder, the following trials are recorded.

In rapid milking a good deal of air is forced into the milk, thus enlarging its bulk and consequently reducing the amount of butterfat in a given quantity by measure. A pipette full of such expanded milk would, therefore, contain less fat theoretically than the same measured quantity of the same milk when it had settled. Whether this difference is large enough to be material is the question to be answered.

In the following table, in the first column are given the dates of the several trials; in the second, the names of the cows, College Pauline America, College Houwtje, College Pauline, College Wayne Pauline and Rhea, being Holsteins with a low per cent of fat; College Dame Le Brocq and College Pogis 2d, Jerseys with high per cent of fat; Aida 2d and Polly's Blossom, Guernseys, with high per cent of fat; Bravura and Becky, Brown Swiss, and Victoria B., a Shorthorn giving milk of medium richness. In the third column is given the per cents of fat when taken by the pipette directly from the unstirred entire mess immediately after milking. At least three samples were thus taken in each instance and the separate readings are givento show their uniformity, all the tests recorded in the same horizontal line being from the same mess.

In the fourth column of the table are given the per cents of fat found in the samples taken from the top of the milk after standing five minutes, and in the fifth column are the per cents found in the samples taken by the pipette from the bottom of the several messes.

TABLE I.

Date.	Name of cow.	Per cent fat taken immediately after milking.	Per cent fat taken from top five minutes after.	Per cent fat taken from bottom five minutes after.
March 25	College Pauline America	3.1; 3.1; 3.1	3.15	3.0
March 25	College Houwtje	3.3; 3.4; 3.3	3.20	3.1
March 27	College Pauline	3.0; 3.0; 3.0	3.00	2.8
March 27	College Pauline America	3.2; 3.2; 3.2	3.25	3.2
March 27	College Wayne Pauline	3.1; 3.2; 3.3	3.00	3.0
March 27	Rhea	3.7; 3.8; 3.7	3.50	3.4
March 26	College Pogis 2d	5.4; 5.5; 5.4	5.60	5.3
March 26	College Dame Le Brocq	7.0; 7.0; 7.0	7.00	6.8
March 26	College Pogis 2d	5.4; 5.5; 5.4	5.60	5.3
March 28	Aida 2d	5.4; 5.4; 5.4	5.50	5.35
March 28	Polly's Blossom	4.8; 4.9; 4.8	4.90	4.85
April 16	Aida 2d	6.0; 6.0; 6.0	5.95	5.85
March 27	Bravura	5.4; 5.4; 5.4	5.40	5.20
March 27	Becky	7.8; 8.0; 7.9	7.95	7.20
April 16	Bravura	3.6; 3.8; 3.7	3.70	3.70
April 16	Becky	4.1; 4.2; 4.3	4.15	4.15
April 16	College Victoria B.	4.1; 4.2; 4.1	4.25	4.25

An examination of the table indicates that in this case the tests of the three samples taken immediately after milking gave fairly concordant results. It does not show, however, that the milk is so thoroughly agitated in the process of milking that to obtain a fair sample of the mess at the close of the operation it is not necessary to stir it. The quantity of air in the milk is evidently not large enough to invalidate the results.

It is evident also that it will not do to allow the mess of milk to stand even for five minutes and then take the sample without stirring. The sample from the top of the mess invariably tested higher than the corresponding sample taken from the bottom. Neither correctly indicates the richness of the milk. Hence it is never safe to take a sample for testing until the milk is most thoroughly stirred either by pouring from one pail into another or by the use of a suitable dipper.

When the milk has been well mixed the pipette is taken between the thumb and the second and third fingers of the right hand. The point is inserted into the milk, which is sucked into the pipette by applying the mouth to the upper end. When the milk has reached a point midway between the mark on the stem of the pipette and the mouth, the forefinger of the right hand is placed quickly over the upper end of the pipette as it is removed from the mouth. By gradually rolling this index finger to the right or left a small quantity of air is admitted and the milk gradually flows out. Be careful to have both the forefinger and the pipette dry. Stop the column of milk when the upper line is even with the mark on the stem, holding the pipette vertically over the milk from which the sample was taken and on a level with the eye. Next place the point of the pipette in the mouth of one of the Babcock test bottles and by removing the finger from the upper end allow the milk to flow into the test bottle. Do not hold the latter vertically, but at an angle with the horizon so that the milk will flow down one side of its neck. After the milk has run out of the pipette, blow out the last drop into the test bottle.

The acid is then measured in the acid measure, and carefully and slowly poured into the test bottle allowing it to flow down the side of the neck. To mix the acid with the milk, take the bottle by the neck and shake it with a horizontal rotary motion to prevent the curd which first forms being thrown up into the neck of the bottle, and to insure the complete dissolving of the milk by the acid. As soon as a sufficient number of bottles have been thus treated, place them in the centrifugal machine, and after the cover is put on, whirl them for five minutes at a speed from 700 to 1,000 revolutions a minute, according to the diameter of the wheel.

After whirling the bottles five minutes in the centrifugal machine the cover is removed and by means of a pipette or other apparatus hot water is added to each bottle until the fat is forced up into the neck nearly to the 10 per cent mark. The cover is then replaced and the bottles are whirled for one minute longer. A convenient arrangement for adding the hot water is to hang a pail above the machine, and siphon the hot water out of it by means of a rubber tube one-fourth of an inch in diameter provided with a pinch cock. In the lower end of this tube is a short piece of glass tubing drawn to a small bore at the opening to convey the water into the bottles. All the fat in the milk will be found after the second whirling in the neck of the bottle. To measure this fat, a pair of dividers is recommended. Hold the bottle in a vertical position opposite the eyes, and place one leg of the dividers on a level with the lower sur-

face of the fat, and move the other leg up to a level with the very top of the upper edge of its concave upper surface. This gives the length of the column of fat. By placing the lower leg at the zero mark of the scale, the point of the upper leg will show the per cent of fat. The neck of the test bottle is graduated to two-tenths of one per cent, but smaller fractions of a per cent may be approximately determined by estimating the distance between these marks.

Throughout the progress of the test after the addition of the acid to the milk and when the per cent of fat is read, the bottles must be warmer than the melting point of butterfat. When many tests are made at a time a suitable vessel should be provided to hold the bottles in upright position in hot water until the fat is read. A tin box 6 inches by 9 inches and 7 inches deep is used in the station dairy room with good success.

As soon as read the contents of the bottles are emptied into some receptacle which is not injured by the acid, and the bottles repeatedly washed out with hot water. They must be kept clean by thoroughly rinsing after each test and not infrequently the necks of the bottles should be swabbed out with a brush made especially for the purpose or with a piece of cloth wrapped about a splinter of wood.

Too much emphasis cannot be laid on the necessity of extreme care and precision in the whole operation to secure accurate and reliable results. The milk must be thoroughly mixed. The pipette of exactly the right capacity must be filled precisely to the mark and the entire contents emptied into the test bottle. The acid must be of the right specific gravity and must be so poured down the inclined neck of the test bottle as to flow below the milk in a distinct clear stratum with a well defined plane of demarkation between.

Methods differ as to whether the milk and acid should be mixed as soon as the latter is added. With a large number of tests to be made at the same time it is the custom at this station to add the acid to a number of bottles sufficient to fill the centrifugal machine before any of them are shaken to mix the acid and milk. The whole lot of bottles are then shaken as rapidly as possible and immediately placed in the centrifugal machine. The results in almost every case are satisfactory. It is recommended, however, by other experimenters that bottles be shaken as soon as the acid is added to the milk and that a hot water bath be provided to keep the contents warm until a sufficient number of bottles have been so treated to fill the machine. They are then taken from the hot bath and whirled at once.

The person who operates the centrifuge should count the turns of the handle and be certain that the required speed is attained and that the whirling is done for the full five minutes. The bottles must then be kept hot until the reading is done. In solidifying, the fat contracts and hence cannot be correctly read. Moreover, the liquid below contracts, breaking up the layer of fat. The invariable rule must therefore be to keep the bottles hotter than the solidifying point of the fat. The reading must be accurately done, the measurements being taken from the top of the curve of the upper surface of the fat to the extreme bottom of the curved lower surface.

With all these precautions observed innumerable trials have shown that the results of the tests are entirely accurate and reliable.

APPLICATION OF THE TEST TO HERD RECORDS.

One method of using the test in the selection of cows and preserving a record of their work has been described. Dairymen have regarded the Babcock test as an expensive, highly theoretical and comparatively valueless piece of machinery. Within the last few years, however, the price of the simple forms of the apparatus has been so reduced as to place them within reach of every cow owner and their value has begun to be appreciated. It is a perfectly practical implement, requiring no great amount of skill, and giving accurate results. The use of the test must become wide spread before much progress can be expected in dairy matters in the State. It is the sole practicable agent for determining the richness of the milk, and taken with the scales is an essential factor in discovering the butter yield and consequent value of cows.

The necessity of selecting the cows which are to manufacture the feed stuffs of the dairymen into milk and butter is so apparent and has been so largely discussed in the current press that no elaboration of it is necessary here.

In the mechanical application of the test to this work two factors are necessary. First, the weight of each mess of milk must be accurately determined by the scales, and second its richness in fat must be accurately determined by the test. To perform these operations with economy, it is better to adopt the plan of the composite test. The results of the examination of a single mess of milk may be altogether misleading. The record for a day may or may not be a correct indication of the capabilities and value of the cow. The record of a week, however, taken in connection with the lapse of the period of lactation and with the other conditions obtaining at the time will give the dairyman a basis for a pretty close estimate of the value of the given cow.

Successive messes of milk from the same cow vary greatly in richness even where the conditions which surround her, are apparently the same. It is unsafe, therefore, to rely upon the test of a single mess as an indication of the quality of the milk given for the entire week. Nor can the amount of fat yielded by a cow in a week be determined by multiplying the amount of milk yielded in that time by the per cent of fat shown by the test of a single mess.

For instance, in the record of Rosa Bonheur 5th, the per cent of fat for noon of June 6th was 3.1 per cent, for evening of the same day it was but 1.8 per cent, while the next morning it was again 3.2 per cent. On the 27th of the same month at noon the milk showed by duplicate test 3.4 per cent fat, while at night of the same day it was but 1.7 per cent, no unusual conditions existing at the time to account for the change. The total milk yield for the week, beginning the 24th of that month was 430.9 pounds. This amount multiplied by 1.7 gives 7.33 pounds fat, multiplied by 3.4 gives 14.66 pounds fat, or just double the first amount.

The actual amount of fat secreted during the week was 9.99 pounds, showing an average per cent of fat of about 2.31.

Where the record of the daily milk yields are preserved on milk sheets at the stable it is not much additional trouble to take a composite sample of the milk of each cow for subsequent testing. A small dipper or a milk thief hangs in a convenient place and at every milking a little of the mess is placed in the fruit jar bearing the name of the cow yielding it.

Once a fortnight or more or less frequently the composite sample is analyzed. In this way a perfect record of the yield of every cow is secured, which should be entered in a book properly ruled, for preservation as part of the permanent records of the farm.

APPLICATION TO CREAMERIES AND CHEESE FACTORIES.

The injustice of paying for milk according to its weight alone and regardless of its quality, has long been apparent. One hundred pounds of milk yielded, for instance, by a Jersey herd may produce 40 or 50 per cent more butter than the same quantity of milk from a herd of Holsteins. The only equitable basis of value is the amount of butterfat which each contains.

Prior to the invention of the Babcock test there were no means available for the economical determination of the richness of milk. But since this machine has come into general use there is no longer a necessity of perpetuating the injustice of pooling milk at an equal price per hundred, regardless of quality.

Were it necessary to test the milk of every patron of the creamery every day, the amount of work involved would preclude the possibility of using the test. The discovery of the fact, that the addition of bichromate of potash or other antiseptic chemicals prevents the curdling of milk has obviated this difficulty, and has rendered it necessary to test the milk but once a week during warm weather, and not more frequently than once a fortnight during the spring, fall and winter.

In the weigh room of the factory there is provided a quart fruit can with a tight cover for each patron of the creamery. A milk thief as described above is used in taking the samples from the weigh can. As many Babcock test bottles are provided as there are patrons. No additional apparatus other than the centrifugal machine, a pipette, acid measure and acid is required for the introduction of the test.

As soon as the milk of the patron is emptied into the weigh can, a sample is taken with the milk thief and placed in the fruit jar which bears his name. The contents of the fruit can are thoroughly mixed at the addition of each successive sample, and the cover tightly screwed on. The milk thief adds a small sample proportioned to the quantity of milk constituting each separate delivery. If the patron brings one thousand pounds today and a ton tomorrow, the sample from today's milk by the milk thief will be exactly one-half the size of the sample taken on the succeeding day, since the milk in the former case will be just one-half as deep in the weigh can as in the latter. The samples, therefore, that accumulate in the fruit can during the week, will represent with substantial accuracy, the milk which has been delivered in that time. Repeated experiments of testing separately each delivery, and testing a composite sample of the same, have shown that the composite tests, give correct results. The following table illustrates one of these experiments performed by one section of the dairy class in the winter of 1894-5, except that instead of taking samples on successive days from the deliveries of the same patron for comparison with the composite test of the same, a sample was taken from the milk of each patron for a separate test and another put in a composite jar with similar samples from the milk of each of the other patrons delivered the same day. In the column of the table immediately

following the dates is the total amount of milk received by that section of the dairy class on the given date. In the next column is the amount of fat shown to be in the milk by testing separately the samples taken from the milk of each patron delivered that day and multiplying the amount of milk which each patron brought by the per cent of fat it was found to contain and adding together these amounts. In the last column is the total amount of fat shown to be in the milk of the given day by testing the composite sample taken from all the deliveries. Seven patrons were delivering milk to the dairy school at the time and the testing was done by inexperienced young men who were learning the manipulaton of the test.

TABLE II.—*Comparison of Composite and Individual Tests.*

Date.	Milk. Pounds.	Fat by sum of individual tests. Pounds.	Fat by composite test. Pounds.
January 23	983.5	39.34	39.47
" 24	812	32.48	32.58
" 25	958	38.32	38.24
" 26	796	32.63	31.06
" 27	1,750	71.75	72.57
" 28	971	38.84	38.41
" 30	1,018	40.52	41.05
" 31	941	36.79	36.31
February 1	845	36.34	36.66
" 2	857.5	32.56	32.71
" 4	975	39.00	39.31
" 5	945	38.78	38.47
" 6	986	38.75	38.68
" 7	947	37.41	37.21
" 8	913.5	39.73	39.05
" 9	1,045	41.96	42.10
Total	15,738.5	635.20	634.68
		634.68	
		.52	

The amount of fat delivered to that section of the school for the time mentioned, as determined by the separate test of each delivery agrees within a half pound of the amount as determined by the composite tests of all the deliveries of each day.

The milk of each patron should be weighed, sampled and tested separately. In the majority of cases composite samples of each patron's milk should be tested weekly. The result of this weekly test should go on the milk sheet at the weigh can so that the patrons may know how their milk is testing. Below is given a partial creamery milk sheet showing the manner in which the record of milk should be kept.

Date, 1895.	John C. White, milk, lbs.	Chris Hansen, milk, lbs.	Michel O'Brien, milk, lbs.	Malcolm McKay, milk, lbs.	William Williams, milk, lbs.	W. V. Vandorn, milk, lbs.	Herman Weis, milk, lbs.
July 8	360	1,244	327	772	383	1,022	362
July 9	457	650	161	375	430	520	264
July 10	466	640	162	380	440	538	276
July 11	446	632	155	370	428	540	260
July 12	452	644	156	366	442	548	272
July 13	459	638	146	368	450	562	239
Per cent fat	3.8	4.1	3.2	4.8	4.2	4.4	3.6

Payments should be made, at least, every month. In cases where the milk is purchased outright payments may be made at shorter intervals but where the price of the milk depends upon the sale of butter it is not practicable to pay more than once a month. In the case of a cooperative company each patron's milk having been tested once a week, the amount of milk brought to the creamery during *that week* by a given patron is multiplied by the per cent of fat shown by its composite test. This will give the amount of fat brought by that patron that week, and by adding the fat thus calculated for the four weeks of the month we get the *amount of fat delivered during the month.*

By adding the amounts of fat delivered by the several patrons we have the total amount of fat received by the creamery during the month. Now upon this amount of butterfat our calculations are based. Suppose for instance that A, B, C, and D are patrons of a creamery and that during the month the milk brought by them has contained the following amounts of butterfat:

A.	150	lbs.
B.	170	"
C.	210	"
D.	320	"
Total	850	"

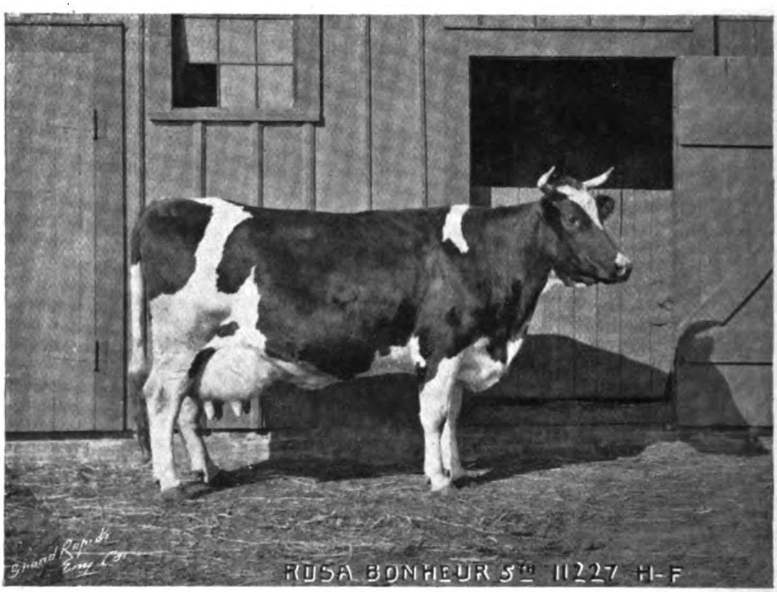
From this 850 pounds of butter fat a thousand pounds of butter may be made, and sold at 25 cents a pound, making the receipts for the month $250.00. From this sum must be taken the total expense of making, say $40.00, leaving $210.00 to be divided among the patrons. Dividing the net sum, $210.00 by 850, the total pounds of fat received, we have $0.24705 a pound for the butterfat. Multiplying the amount of butterfat in each patron's milk by this price per pound gives the amount each should receive.

A—150 lbs. at $0.24705	$37 06
B—170 " " .24705	42 00
C—210 " " .24705	51 88
D—320 " " .24705	79 06
Total	$210 00

The method is practically the same where a stated sum per pound is allowed for making and marketing the butter. Instead, however, of subtracting the actual expense of running the factory from the gross receipts, $250.00, we multiply the total number of pounds of butter made by the amount agreed upon for making, usually $0.04 per pound. In case 1,000 pounds of butter were sold and this multiplied by $0.04 there would be $40.00 to be allowed for making and $210.00 to be divided among the patrons exactly as in the previous case.

In cases where the milk is purchased outright the same principle holds good and the milk that will make the most butter should bring the most money to the producer.

It must be remembered in this connection that the Babcock test shows the butterfat in the milk delivered and not the amount of butter which can be made from it. One hundred pounds of butter contains much less than one hundred pounds of fat. The amount of the latter required for one hundred pounds of butter varies, of course, with the water, salt, and other ingredients which the maker incorporates in it. By proper manipulation it is possible to make one hundred pounds of butter from eighty pounds of fat as shown by the test. It may under other circumstances require ninety pounds of fat to make one hundred pounds of butter. The test cannot therefore show the amount of butter to be produced from one hundred pounds of milk, but must content itself with showing the amount of fat which it contains, and leave the question of the amount of butter to the maker.



ROSA BONHEUR, 5th, 11277, H. F. H. B

RECORDS.

One day	106.75 lbs milk,	3.22 lbs fat.
One week	726.25 lbs milk,	20.47 lbs fat.
Ten days	1,033.5 lbs milk,	28.75 lbs fat.
Thirty days	2,989.5 lbs milk,	82.16 lbs fat.

PREVIOUS RECORDS.

1892, ten months	8,532.75 lbs milk.
1893, thirteen months	14,487 lbs milk.

ROSA BONHEUR FIFTH, 11227 H. F. H. B.

The pedigree of Rosa Bonheur 5th, 11227 H. F. H. B., whose photograph appears on the opposite page, and whose record is given below is conspicuously short. Her dam, Rosa Bonheur, 890 H. H. B., was selected by one of the firm of Smiths & Powell, of Syracuse, New York, from the herd of D. Hoogetoorn, Beemster, North Holland. Nothing is known of the breeding of the sire or dam of the older Rosa Bonheur. The mother was represented as being a large, fine, black and white cow which had given more than fifty quarts of milk in a day. This Mr. Hoogetoorn was a first-class breeder, a good feeder, and an excellent judge of Holsteins. She was imported in September, 1879, by Smiths & Powell, as a heifer and was purchased from them by Wm. Westover, Bay City, Mich. She developed into a very large cow. As a two-year-old she gave 13,356 pounds of milk in a year. No farther definite statement as to her actual yield is obtainable.

The sire of Rosa Bonheur 5th was Meadowbrook Chief, 1969 H. F. H. B., by Ykema 322 D.—F. H. B., out of Anna Kaastra, 1112 D. F. H. B. Both imported directly into Michigan, from the best herds of the old country, by Mark Seeley, of the firm of Phelps & Seeley, of Pontiac, Michigan.

Rosa Bonheur 5th was calved March 20, 1888. On the 20th of February, 1894, therefore, when this record began, she was 5 years and 11 months old. Her weight at that time and for the months following varied but a few pounds from 1,750 until she became pregnant on the 22d of June, 1894, when it rapidly ran up to 1,850 pounds by the close of the year. She is therefore a very large cow. In general outline she approaches the ideal dairy type, being distinctly wedge shaped, deep through the sacrum and udder, and much less so through the shoulder and brisket, with an immense belly and udder. The latter measured, one month after calving, 5 feet and 7 inches in circumference, while the girth around the largest part of the belly was 8 feet and 6 inches. The head, in size, is in due proportion to the body, and is long rather than wide. The head back of the horns is broad, giving room for a large brain. The neck is thin, fine, slightly drooping and moderately long. The chine is remarkably open, giving a decided saw-like feeling to the back. The withers are very sharp and thin, while the chest midway between the brisket and the top of the shoulder is broad giving ample room for the immense lung power required in the digestion of the quantity of food which the cow consumes. There is a decided droop in the back between a point one-third of the distance from the top of the shoulders to the hip bone, and the rise of the pelvic arch. The ribs are open, and the distance from the last rib to the point of the hip bone is 14 inches. The hips and loin are fairly strong and rounded. The height of the cow at the shoulder is 4 feet and 10 inches; at the hips, 5 feet. The udder has a very long connection with the body, extending well up to the vulva behind, and a good distance in front, as is shown by the photograph. There is a strong development of the umbilical region and the milk veins are long and tor-

tuous ending without extension in large milk wells. The thighs are somewhat thin but not cat-hammed. Her skin is mellow and unctuous.

In disposition she is uniformly quiet, docile and motherly, an enormous eater, never being off her feed, and not dainty in her appetite.

Although the weather was extremely cold during the latter days of February and early March, which immediately succeeded the birth of her calf, she was kept in the box stall shown in the cut without further protection from the extreme cold than was afforded by the battened boards and loose door. Whenever the days were pleasant and sunshiny she was allowed to exercise in the barnyard, and visited the water trough for her water supply. Indeed the doors of her stall were frequently left open as the cow gave every evidence of enjoyment of the keen and invigorating air.

She was milked thrice daily, at 4:30 a. m. and 12:30 and again at 8:30 p. m., by the same milker.

In the table following is given the weekly milk and butterfat record of the cow beginning February 21, 1894. The amount of milk is of course determined by adding together the twenty-one successive messes which constituted a week's yield. The weekly butterfat represents the pounds of fat yielded in the week ending with the date given, as determined by separate and duplicate tests of each of the twenty-one messes of milk. Each mess of milk was multiplied by the average per cent of fat shown by the test for that mess, and the sum of these products for the twenty-one messes is the amount reported in the column marked "pounds butterfat weekly."

The distinction between butterfat and butter must be kept clearly in mind. Butter is butterfat plus water, salt, a little casein and a small per cent of other ingredients. It is evident then that the amount of butter which can be made from the milk of a given cow for a given time depends on the skill of the butter maker as well as the yield of the cow. Her record cannot, therefore, be correctly expressed in terms of butter. The scales and the Babcock test on the contrary point out accurately and distinctly the exact amount of butterfat which the cow yields per day, and correctly measures her performance. We have given therefore in the records of the cows to be included in this bulletin the yields of butterfat as being a true measure of their performance.

There is also given in the table the amount of silage, grain, oil meal and roots consumed in the weekly periods corresponding with those of the milk and fat records. The amount of dry matter in the weekly food supply is also shown and the pounds of dry matter consumed for each pound of butterfat.

The grain ration consisted of 100 pounds of corn meal, 75 pounds of oat meal and 25 pounds of bran, mixed. The oil meal is given separately.

The roots were mangel-wurzels. Besides the feeds mentioned in the table the cow ate during the winter 63 pounds of mixed hay.

TABLE III.—*Weekly Milk and Fat Record of Rosa Bonheur 5th.*

Week ending.	Pounds milk weekly.	Average per cent fat.	Pounds butter-fat weekly.	Silage, lbs.	Grain, lbs.	Oil meal, lbs.	Roots, lbs.	Dry matter, lbs.	Pounds dry matter to 1 pound butter-fat.
Feb. 27	682.00	2.79	19.05	500	148	48	287	336.76	17.67
Mar. 6	723.75	2.78	20.14	526	162	51	283	363.42	18.04
" 13	704.00	2.67	18.81	538	169	51	202	364.69	19.36
" 20	663.25	2.93	19.41	656	177	54	244	409.88	21.11
" 27	680.25	2.84	19.34	655	168	68	291	414.59	21.43
April 3	648.50	3.05	19.78	677	184	42	221	408.96	20.64
" 10	576.25	3.08	17.81	535	154	23	211	326.04	18.30
" 17	583.25	2.97	17.38	579	182	37	119	366.07	21.06
" 24	558.80	2.85	15.92	475	167	29	59	314.02	19.72
May 1	486.70	2.92	14.23	--------	--------	--------	--------	--------	--------
" 8	529.20	2.81	14.88	--------	--------	--------	--------	--------	--------
" 15	503.30	2.59	13.04	--------	--------	--------	--------	--------	--------
" 22	506.00	2.66	13.47	--------	--------	--------	--------	--------	--------
" 29	509.50	2.56	13.04	--------	--------	--------	--------	--------	--------
June 5	497.30	2.48	12.33	--------	--------	--------	--------	--------	--------
" 12	463.40	2.70	12.50	--------	--------	--------	--------	--------	--------
" 19	445.20	2.58	11.50	--------	--------	--------	--------	--------	--------
" 26	456.60	2.36	10.78	--------	--------	--------	--------	--------	--------
July 2	423.30	2.31	9.77	--------	--------	--------	--------	--------	--------
" 9	401.50	2.56	10.31	--------	--------	--------	--------	--------	--------
" 16	385.60	2.52	9.78	--------	--------	--------	--------	--------	--------
" 23	379.80	2.53	9.62	--------	--------	--------	--------	--------	--------
" 30	387.70	2.48	9.63	--------	--------	--------	--------	--------	--------
Aug. 6	388.40	2.41	9.36	--------	--------	--------	--------	--------	--------
" 13	356.20	2.78	9.90	--------	--------	--------	--------	--------	--------
" 20	362.70	2.61	9.45	--------	--------	--------	--------	--------	--------
" 27	345.10	2.61	9.00	--------	--------	--------	--------	--------	--------
Sept. 3	314.50	2.69	8.47	--------	--------	--------	--------	--------	--------
" 10	300.10	2.60	7.80	--------	--------	--------	--------	--------	--------
" 17	264.40	2.72	7.20	--------	--------	--------	--------	--------	--------
" 24	278.60	2.68	7.49	--------	--------	--------	--------	--------	--------
Oct. 1	295.60	2.86	8.48	--------	--------	--------	--------	--------	--------
" 8	282.40	2.96	8.26	--------	--------	--------	--------	--------	--------
" 15	279.20	2.82	7.89	--------	--------	--------	--------	--------	--------
" 22	216.30	2.81	6.10	--------	--------	--------	--------	--------	--------
" 29	169.40	2.94	4.99	--------	--------	--------	--------	--------	--------
Nov. 5	151.00	3.05	4.60	--------	--------	--------	--------	--------	--------
" 12	133.20	2.78	3.71	--------	--------	--------	--------	--------	--------
" 19	119.50	3.29	3.94	--------	--------	--------	--------	--------	--------
" 26	122.30	3.07	3.77	--------	--------	--------	--------	--------	--------
Dec. 3	123.00	3.06	3.77	--------	--------	--------	--------	--------	--------
" 10	105.90	3.22	3.42	--------	--------	--------	--------	--------	--------
" 17	93.90	3.42	3.21	--------	--------	--------	--------	--------	--------
" 24	84.50	3.06	2.59	--------	--------	--------	--------	--------	--------
" 31	62.60	3.34	2.09	--------	--------	--------	--------	--------	--------
Total	17,013.45	--------	469.31	--------	--------	--------	--------	--------	--------

The total amount of milk secreted in the six weeks ending April 3, was 4,101.75 or an average of 97.66 pounds per day. The amount of butterfat secreted in the same time is 116.53 pounds or an average of 2.77 pounds per day. The Association of the Agricultural Colleges and Experiment Stations has adopted as the standard factor for the conversion of known, correct records of butterfat into assumed and estimated butter the fraction one-sixth. Under this rule one-sixth of the weight of the butterfat is added to it and the result is to be recorded as butter. For instance, 100 pounds of butterfat, it is assumed, would make one hundred and sixteen and two-thirds pounds of butter. Applying this rule to the records just given, 116.53 pounds of butterfat would make 135.95 pounds of butter, 22.66 pounds of butter per week, or 3.23 pounds of butter per day for the entire six weeks.

After the cow was turned to grass on the 25th of April there was a gradual but somewhat irregular decline in the yield of both milk and butterfat and a subsequent rise succeeded by a period of four weeks in which the yield was almost perfectly uniform in quantity and richness. Thereafter the decrease in the quantity secreted daily is quite perceptible.

The average per cent of fat did not increase regularly with the lapse of the period of lactation. In March it was 2.805 per cent, in April 3.24 per cent, in May 2.71 per cent, in June 2.53 per cent, in July 2.44 per cent, in August 2.60 per cent, in September 2.67 per cent and in October 2.88 per cent.

To exhibit in detail the record of this cow for the first six weeks of her milking period, the next table gives the pounds of milk, its per cent of fat and the weight of fat yielded at each milking. As a matter of convenience the noon, night and morning messes are combined in the order named and constitute the yield as given for a day.

Beginning with the 26th of February there were seventeen consecutive days in which she gave 100 pounds per day except March 2, 7, 9 and 11, when the yields were within three-quarters of a pound of that amount, the average for the seventeen days being slightly over 102 pounds. The yields of both milk and fat in corresponding messes on successive days were singularly uniform.

The average yield in the morning for the first twenty-two days was 36.33 pounds of milk containing .91 pounds fat. The greatest variation from this amount was on the morning of the 26th of February when the mess weighed 39 pounds, a difference of but 2.67 pounds. The fat yields were also constant, differing less than .2 of a pound from the average except on the morning of the 23d of February and again on the 14th of March.

The noon messes for the same period were characterized by a similar uniformity, the widest variations being 2.4 pounds in milk from the average 32.85 pounds and .21 pounds fat from the average, .983 pound.

In the evening except in three cases the messes of milk did not vary more than 2.1 pounds from the average, 31.33 pounds and the fat was within .24 pounds of the average, .90 pounds.

The same evenness of flow is equally marked through the remainder of the six weeks. These facts go far to demonstrate the perfect working order of the internal machinery of the cow and the adjustment of the ration to her wants.

TABLE IV.—*Record of Rosa B. for six weeks by single messes.*

Date.		Milk. Pounds.	Per cent fat.	Fat. Lbs.	Daily yield milk. Lbs.	Daily yield fat. Lbs.
February 20	m.	30.5	2.5	.762		
	p. m.	26.5	2.6	.689		
February 21	a. m.	34.5	2.2	.759	91.5	2.21
	m.	30.5	2.8	.854		
	p. m.	31.0	2.8	.868		
February 22	a. m.	34.0	2.8	.952	95.5	2.674
	m.	31.0	3.1	.961		
	p. m.	30.0	3.0	.90		
February 23	a. m.	34.75	3.6	1.251	95.75	3.112
	m.	30.5	3.1	.945		
	p. m.	26.25	2.6	.682		
February 24	a. m.	36.5	2.6	.949	93.25	2.576
	m.	31.75	3.4	1.079		
	p. m.	29.25	3.0	.877		
February 25	a. m.	36.75	2.0	.735	97.75	2.691
	m.	33.0	3.1	1.023		
	p. m.	32.75	3.2	1.048		
February 26	a. m.	39.0	2.5	.975	104.75	3.046
	m.	33.75	3.0	1.012		
	p. m.	31.75	2.7	.857		
February 27	a. m.	38.0	2.7	.874	103.5	2.743
	m.	35.0	3.4	1.19		
	p. m.	33.0	2.6	.858		
February 28	a. m.	38.0	2.3	.874	106.0	2.923
	m.	34.75	3.1	1.076		
	p. m.	31.5	2.8	.882		
March 1	a. m.	38.0	2.4	.912	104.25	2.87
	m.	34.25	3.3	1.13		
	p. m.	29.75	3.2	.952		
March 2	a. m.	35.75	2.3	.822	99.75	2.904
	m.	33.5	3.0	1.005		
	p. m.	31.75	2.8	.889		
March 3	a. m.	36.75	2.2	.808	102.00	2.702
	m.	33.5	3.0	1.005		
	p. m.	33.0	3.0	.99		
March 4	a. m.	36.75	2.2	.808	103.25	2.808
	m.	33.75	3.0	1.012		
	p. m.	33.0	3.2	1.056		
March 5	a. m.	36.75	2.2	.808	103.50	2.876
	m.	35.25	3.0	1.057		
	p. m.	34.75	3.3	1.146		
March 6	a. m.	36.00	2.4	.864	106.00	3.067
	m.	33.50	3.0	1.005		
	p. m.	30.25	2.4	.726		
March 7	a. m.	35.50	3.1	1.10	99.25	2.831
	m.	33.25	2.8	.931		
	p. m.	32.50	3.3	1.072		
March 8	a. m.	37.50	2.4	.90	103.25	2.903
	m.	32.75	3.20	1.048		
	p. m.	31.00	2.6	.806		
March 9	a. m.	36.00	2.4	.864	99.75	2.718
	m.	31.75	3.0	.952		
	p. m.	33.00	3.0	.99		
March 10	a. m.	36.00	2.3	.828	100.75	2.77
	m.	31.50	2.6	.819		
	p. m.	32.50	2.8	.91		

TABLE IV.—*Continued.*

Date.		Milk. Pounds.	Per cent fat.	Fat. Lbs.	Daily yield milk. Lbs.	Daily yield fat. Lbs.
March 11	a. m.	35.25	2.3	.81	99.25	2.589
	m.	33.50	3.0	1.005		
	p. m.	31.25	2.5	.781		
March 12	a. m.	35.50	2.5	.887	100.25	2.673
	m.	35.00	2.6	.91		
	p. m.	31.50	2.4	.756		
March 13	a. m.	35.00	2.6	.91	101.50	2.576
	m.	30.50	2.8	.854		
	p. m.	33.00	3.2	1.056		
March 14	a. m.	37.00	3.5	1.295	100.50	3.205
	m.	28.00	3.1	.868		
	p. m.	29.25	2.0	.585		
March 15	a. m.	35.00	2.6	.91	92.25	2.863
	m.	33.00	3.3	1.069		
	p. m.	32.50	3.2	1.04		
March 16	a. m.	34.00	2.9	.986	99.50	3.115
	m.	32.25	2.6	.838		
	p. m.	31.25	2.7	.843		
March 17	a. m.	33.00	2.8	.924	96.50	2.805
	m.	30.00	3.2	.96		
	p. m.	30.75	3.2	.984		
March 18	a. m.	33.00	3.0	.99	93.75	2.934
	m.	28.75	3.2	.92		
	p. m.	31.75	2.8	.889		
March 19	a. m.	33.75	3.0	1.012	94.25	2.821
	m.	27.75	3.0	.832		
	p. m.	29.25	2.7	.789		
March 20	a. m.	29.50	2.5	.737	86.50	2.358
	m.	32.25	2.7	.87		
	p. m.	30.75	2.9	.891		
March 21	a. m.	33.25	2.3	.764	96.25	2.525
	m.	31.00	2.9	.899		
	p. m.	31.25	2.3	.718		
March 22	a. m.	34.25	2.3	.787	96.50	2.404
	m.	30.00	3.5	1.05		
	p. m.	31.75	2.8	.889		
March 23	a. m.	36.25	2.9	1.051	98.00	2.99
	m.	33.75	3.6	1.215		
	p. m.	32.75	2.9	.949		
March 24	a. m.	35.25	2.4	.846	101.75	3.01
	m.	31.75	2.8	.889		
	p. m.	33.00	2.8	.924		
March 25	a. m.	36.00	2.7	.972	100.75	2.785
	m.	30.50	3.4	1.037		
	p. m.	29.00	3.2	.928		
March 26	a. m.	33.00	2.7	.891	93.5	2.856
	m.	31.25	3.2	1.00		
	p. m.	31.25	3.1	.968		
March 27	a. m.	32.00	2.5	.80	94.50	2.768
	m.	33.25	3.2	1.064		
	p. m.	30.00	3.2	.96		
March 28	a. m.	34.75	2.5	.868	98.00	2.892
	m.	30.50	3.1	.945		
	p. m.	32.50	3.3	1.072		
March 29	a. m.	34.25	2.8	.959	97.25	2.976
	m.	28.75	2.9	.833		
	p. m.	30.25	3.0	.907		

TABLE IV.—*Concluded.*

Date.		Milk.				
		Pounds.	Per cent fat.	Fat. Lbs.	Daily yield milk. Lbs.	Daily yield fat. Lbs.
March 30	a. m.	32.75	2.7	.884	91.75	2.624
	m.	30.75	3.0	.922		
	p. m.	30.50	3.1	.945		
March 31	a. m.	31.50	2.5	.787	92.75	2.654
	m.	30.00	3.1	.93		
	p. m.	28.50	2.8	.798		
April 1	a. m.	32.50	2.5	.812	91.00	2.54
	m.	30.00	3.1	.93		
	p. m.	29.50	2.8	.826		
April 2	a. m.	30.5	2.6	.793	90.00	2.549
	m.	28.25	3.0	.847		
	p. m.	27.75	3.0	.832		
April 3, a. m.		31.75	2.7	.857	87.75	2.536

In the records of the three cows, Rosa Bonheur, Houwtje D. and Belle Sarcastic the economy of production is measured by the pounds of dry matter consumed for each pound of butterfat in the yield. For instance, if in a given week a cow gives 500 pounds of milk, containing 20 pounds of fat and consumes in the same period fodder containing 400 pounds of dry matter, she would return one pound of fat for every 20 pounds of dry matter eaten, and this would be the measure of the economy of her production.

It is necessary to take the dry matter in the ration and not its gross weight as a basis for comparison for very evident reasons. The water in the different fodders adds to their palatability undoubtedly, but contributes nothing to the support of the animal. The proportion of water in the different feeding stuffs varies within wide limits. Roots, silage, green grass and other succulent materials contain from seventy to over ninety pounds per hundred of water, while the grains and their by-products rarely have over twelve pounds per hundred. One hundred pounds of silage contains 73.6 pounds of water. Were this water evaporated there would remain 26.4 pounds of dried matter or dry matter as it is commonly called.

Mixed hay such as was fed these cows contained but sixteen pounds of water per hundred pounds and eighty-four pounds of dry matter. A pound of the dry matter of mixed hay is for most purposes of about the same value as a pound of dry matter in corn silage, hence the feeding value of a hundred pounds of hay would be worth as much more than the feeding value of the same weight of silage as 84.6 is greater than 26.4 or more than three times as much. To compare therefore the efficiency of two rations, one composed largely of silage and the other of hay, the amount of dry matter in each must be determined and the comparison made on that basis.

To the practical dairyman, the relative value of two cows is very largely measured by the amount of dry matter in the feed each consumes per pound of fat in the milk yield. No matter how big a record a cow makes, if the amount of food she consumes meantime is so great as to be worth more than the butter yielded she is an unprofitable cow. The measure of her value is the amount of dry matter in the food she requires per pound of fat in her milk.

The general plan in feeding Rosa Bonheur was to determine beforehand what feed stuffs were obtainable and what therefore the constituents of the ration should be and then trust to the skill of the feeder to adjust the quantity and relative proportions of the various ingredients to the wants of the cow. She was fed, cared for and milked by Mr. Richard Harrison, the college herdsman. He made a careful study of her personality and of the whims and caprices of her appetite. This thorough acquaintance with the individuality of the animal under test was absolutely essential to the attempt to feed her to the highest limit. The strain on the system of a cow that consumes, in the space of 24 hours, 114 pounds of silage, 12 pounds corn meal, 9 pounds of oat meal, 3 pounds of bran, 9 pounds of oil meal and 27 pounds of roots is something enormous. With the whole organization thus at its highest tension the danger of mistake and accident is imminent. The slightest indication of anything going wrong, must be instantly recognized, rightly interpreted, and immediately corrected.

In the present case it is enough to say that the cow never failed to take her ration regularly and with relish. Naturally her appetite fluctuated, and these variations met with the requisite rational changes in feed supply. As the weather grew warmer towards spring the quantity of food she could be induced to eat grew less and with the decrease in food consumption there was a corresponding fall in the milk and butter yields. It was impossible therefore to fix any definite ration for consecutive days; the proportions and amounts of the several ingredients being varied to conform to the varying appetite, looseness of the bowels and condition of the milk glands.

The silage was from several varieties of Dent corn, mixed, fairly glazed when cut and perfectly kept in the silo. Of this feed Rosa was particularly fond, and she was allowed nearly all she would eat, the daily amounts varying from 75 pounds in the last days of February, about 85 pounds through early March to the 12th, and then from 90 to 100 pounds and even higher on exceptional days to the first of April and the beginning of warmer weather when the daily consumption again dropped to 85 pounds, 75 pounds, and even less just as the cow was turned to pasture, April 25.

Oil meal was the grain feed for which she displayed the greatest fondness. Beginning with 3, 4 and 5 pounds per day, the amount was rapidly increased to 10 pounds daily on the last two days of February, then dropped to amounts varying from 6 to 9 pounds daily through March, according to the appetitie of the cow. The proportional parts of the other grain feed have already been given, 100 pounds corn to 75 pounds oats and 25 pounds roller process wheat bran. Of this grain feed the daily consumption was reasonably constant, varying between 22 and 27 pounds, usually 24 pounds.

The daily program in feeding was in general as follows: About 4:30 a. m. just before milking she was fed silage, roots and grain feed mixed, unless the cow preferred them separate when her wishes were acceded to. At 11:30 a. m. another feed consisting again of a mixture of the silage, roots and grain feed was given, and finally about 6:00 p. m. she received her regular evening feed.

In table 5 are recorded the per cents of the various nutrients in the food materials used. These figures are taken from Woll's "Dairy Calendar for 1895."

TABLE V.—*Composition of Feeding Stuffs.*

	Dry matter, per cent.	Digestible protein, per cent.	Digestible carbo-hydrates, per cent.	Digestible fat, per cent.
Silage	26.4	1.3	14.0	.7
Corn	89.1	7.1	62.7	4.2
Oats	89.0	9.1	44.7	4.1
Bran	88 0	12.6	44.1	2.9
Oil meal O. P.	90.8	28.3	32.8	7.1
Mangel-wurzels	10.0	1.1	4.8	.2
Mixed hay	84.0	3.6	43.7	1.0

In the next table is given the average daily ration of dry matter, digestible protein, digestible carbohydrates, and digestible fat for several weeks and the nutritive ratios.

TABLE VI.—*Nutrients in Average Daily Ration.*

Week ending.	Dry matter.	Digestible protein, lbs.	Digestible carbo-drates, lbs.	Digestible fat, lbs.	Nutritive ratio, 1 to
Feb. 27	48.11	5.08	25.62	1.91	5.9
Mar. 6	51.91	5.49	26.24	2.06	5.8
" 13	52.09	5.42	21.90	2.09	6.0
" 20	58.55	5.98	31.70	2.31	6.2
" 27	59.22	6.30	31.34	2.34	5.9
April 3	58.48	5.58	31.54	2.22	6.6
" 10	46.58	4.17	25.44	1.72	7.1
" 17	53.29	5.02	27.47	2.05	6.49
" 24	44.86	4.22	24.19	1.75	6.7

The American standard daily ration for a cow weighing 1,750 pounds would be 3.85 pounds of digestible protein, 23.275 pounds of digestible carbohydrates and 1.225 pounds of digestible fat, the ratio being 1 to 6.9. Rosa consumed very much more than the standard of all the nutrients, especially of the protein, the ration for the week ending March 27, being notably conspicuous in this regard

The feeding period covered sixty-three days. Dividing the weight of the various food stuffs eaten by 63 we have the average amount of each in a day's ration This was 81.6 pounds of silage, 11.99 pounds of corn meal, 8.99 pounds of oat meal, 3 pounds of bran, 6.31 pounds of oil meal, and 29.63 pounds of mangels. Reducing this ration to the amount consumed per 1,000 pounds live weight per day we have 46.60 pounds of silage, 6.85 pounds corn meal, 5.13 pounds of oat meal, 1.72 pounds of bran, 3.6 pounds of oil meal, and 16.93 pounds of roots.

The average daily consumption of dry matter was 52.43 pounds or almost exactly thirty pounds of dry matter per 1,000 pounds live weight. The average daily yield of butterfat for the same period was 2.66 pounds or

1.52 pounds per 1,000 pounds live weight per day and one pound of fat for each 19.70 pounds dry matter eaten. This expenditure of dry matter for one pound of fat would rightly be considered unusually economical under ordinary conditions, but this record was made in the coldest weather of an unusually cold winter, with the thermometer ranging below zero for several successive nights and with the cow in an isolated box stall with nothing between her body and the outdoor air except one thickness of boards loosely battened.

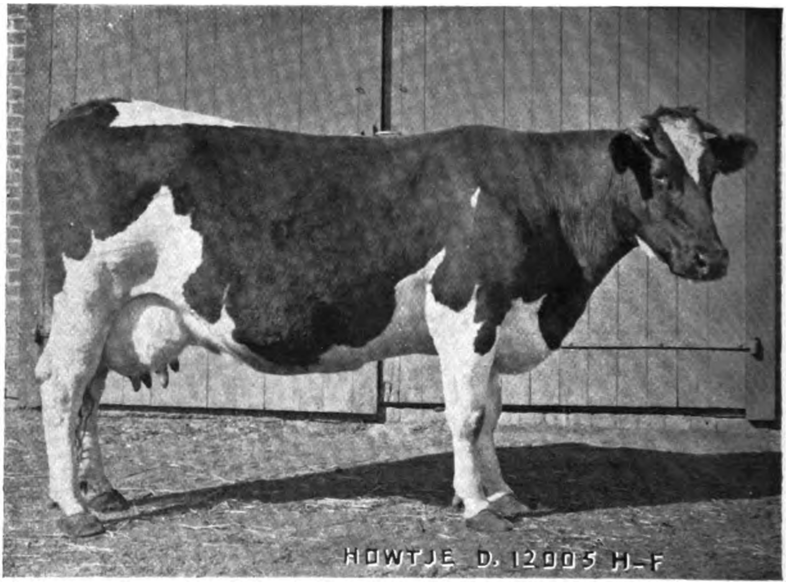
The prices of the several feed stuffs are so variable that it is of but doubtful expediency to record here any estimate of the food cost of the butterfat or butter yielded by the cow. At best, enough factors are unknown or empirically assumed to cast grave doubt on such calculations and the results are perhaps quite as often misleading as otherwise. So many inquiries have been received at the station, however, as to the actual financial economy of the work of Rosa Bonheur that it seems wise to introduce a brief statement of the known and estimated food cost of her products. The feed stuffs have the following values per ton respectively: Silage, $2.00; mangels, $2.50; mixed hay, $6.00; corn meal, $19.00; bran, $14.00; oil meal, $22.75; oat meal, $16.00. The total cost of the food consumed for the sixty-three days was as follows:

5,181	pounds	silage at $2.00 per ton	$5 18
755.5	"	corn meal at $19.00 per ton	7 18
566.63	"	oat meal at $16.00 per ton	4 53
188.87	"	wheat bran at $14.00 per ton	1 32
398	"	oil meal at $22.75 per ton	4 53
1 867	"	mangels at $2.50 per ton	2 33
63	"	hay at $6.00 per ton	19
		Total	$25 26

If the cow is to be credited with the butterfat alone in her milk this would make the 167.64 pounds of fat secreted in the 63 days cost in food, at the prices assumed, 15.07 cents per pound. The butter actually sold for 25 cents per pound and if we assume that one-sixth should be added to the butterfat to estimate the butter made from it we should have 195.41 pounds of butter, which at 25 cents per pound, would bring $48.85. On this basis there would then be an estimated profit of $23.59.

The total quantity of milk yielded in the sixty-three days was 5,820 pounds. Of this amount 85 per cent or 4,947 pounds was skim milk. The skim-milk contained by repeated tests 8.50 per cent total solids. It was fed to pigs and was worth over 20 cents per hundred for that purpose. At this rate the 4,947 pounds was worth $9.89 which should be added to the $23.59 making the gross profit $33.48 for the sixty-three days. Subtracting the $9.89 from the $25.26, cost of the food for the sixty-three days there is left $15.37 as the net food cost of the 167.64 pounds of butter fat or $0.0916 per pound.

Twenty-one pounds of the mixture of 100 pounds of corn, 75 pounds of oats and 25 pounds of bran was given to the cow daily after she was turned to pasture.



HOUWTJE D., 12005, H. F. H. B.

RECORDS.

One day	93.0 lbs milk,	2.96 lbs butter fat.
Seven days	628.2 lbs milk,	18.79 lbs butter fat.
One year	19,025.0 lbs milk,	660.14 lbs butter fat.

PREVIOUS RECORDS.

1892, eleven months	11,323.5 lbs milk.
1893, ten months	10,780.0 lbs milk.

RECORD OF HOUWTJE D. 12005, H. F. H. B.

This cow was bred by W. K. Sexton, of Howell, Mich., and was calved March 12, 1888. Her dam was Houwtje, 2941 H. H. B., bred by Gerritt Laan, Hoogcarspel, North Holland, and imported June 21, 1882, by W. K. Sexton. Houwtje gave as a three year old, 53 pounds of milk per day. In the ninth month of her milking she produced a pound of butter from 17 pounds and 3 ounces of milk and has since given 85 pounds and 6 ounces of milk in a single day. The sire of Houwtje D. was Jumbo Boy No. 1993 H. H. B., bred by H. Buiterveld, Poppingawier, Friesland. He was imported in 1882, also by W. K. Sexton. The dam of this bull was Boutsje, 2568 H. H. B. This cow gave on common feed 38 pounds of milk per day at two years old, and her dam gave 18 pounds of butter in seven days, and 87 pounds of milk in a single day. The sire of Jumbo Boy was the prize winner as the best bull of any age or breed in the Netherlands. His dam had a milk record of 85 pounds of milk per day, 20½ pounds of butter in seven days, and the dam of his sire gave 86 pounds of milk in a day and 18¾ pounds of butter in seven days.

The excellence of the ancestry of the cow would warrant us in expecting her to be a good milker.

Houwtje D. has in most respects a typical dairy form as to general contour, being distinctly wedge shaped and very deep through the abdomen and udder, and rather too small in girth behind the shoulders.

Her head is long, inclined to be coarse and somewhat defective in width at the base of the horns. Her temperament is quiet almost to the point of stupidity. The neck is thin, long and slightly drooping. The withers are broad rather than sharp, and the crops full rather than cut out, differing in these two important respects from the ideal form.

The lean, slanting shoulder, uncovered open ribs, and serrated, strong, prominent back of the dairy cow are present. The hips are broad and level with pin-bones unusually high and wide apart. The cow carries a good amount of flesh. The udder, though somewhat uneven, is well developed, slightly meaty in texture and extends well forward.

Her weight varied little from 1,560 pounds up to the middle of July when it gradually increased to 1,600 pounds by the 1st of January following.

Her last calf was dropped April 25, 1894, at which time she was 6 years, 1 month and 13 days old.

She became with calf on the 9th day of March, 1895.

The records of her yields of milk and butterfat began on the 3d day of May, 1894, and are given by weeks in the following table. As with Rosa Bonheur, the milking was done thrice daily to the 3d day of March, 1895.

Thereafter she was milked twice per day only. Each mess was tested in duplicate by the Babcock test after weighing.

The cow was turned to grass before this record began. The pasture was supplemented by a grain ration of 21 pounds of the mixture already spoken of as being fed to Rosa Bonheur 5th, viz: 100 pounds corn meal, 75 pounds oats and 25 pounds of bran.

. TABLE VI.—*Milk and fat record, Houwtje D.*

Week ending.	Milk, lbs.	Fat, per cent.	Fat, lbs.
May 9	533.2	2.91	15.54
" 16	619.5	2.71	16.82
" 23	625.0	2.98	18.64
" 30	596.1	2.94	17.51
June 6	588.3	2.86	16.87
" 13	601.3	2.80	16 84
" 20	570.5	2.93	16.74
" 27	566.9	2.69	15.30
July 4	556.5	2.47	13.80
" 11	511.4	2.76	14.15
" 18	483.3	2.86	13.81
" 25	489.6	2.93	14.34
Aug. 1	481.5	2.97	14.41
" 8	469.3	3.33	15.65
" 15	461.4	3.08	14.20
" 22	456.6	3.13	14.31
" 29	431.4	3.49	15.08
Sept. 5	406.8	3.25	13.25
" 12	371.2	3.46	12.85
" 19	390.9	3.41	13.34
" 26	374.1	3.28	12.27
Oct. 3	376.5	3.23	13.17
" 10	391.2	3.67	14.39
" 17	378.3	3.57	13.54
" 24	375.7	3.49	13.14
" 31	354.5	4.06	14.41
Nov. 7	355.7	3.77	13.42
" 14	298.9	3.83	11.45
" 21	302.7	3.95	11.98
" 28	299.0	4.38	13.10
Dec. 5	296.0	4.02	11.92
" 12	269.3	4.10	11.06
" 19	291.7	4.17	12.17
" 26	287.0	4.07	11.68
Jan. 2	285.1	4.13	11.80
" 9	267.0	4.15	11.40
" 16	250.1	4.12	10.31
" 23	252.0	4.34	10.95
" 30	250.5	4.55	11.49

Week ending.	Milk, lbs.	Fat, per cent.	Fat, lbs.
Feb. 6	250.8	4.45	11.18
" 13	227.4	4.71	10.73
" 20	233.3	4.32	10.08
" 27	247.8	4.46	11.07
Mar. 6	223.2	4.33	9.67
" 13	218.3	4.10	8.95
" 20	186.7	4.23	7.90
" 27	214.1	4.43	9.44
April 3	210.3	4.11	8.65
" 10	208.8	4.12	8.51
" 17	195.3	4.41	8.63
" 24	201.2	4.34	8.74
May 1	191.2	4.34	8.31
May 2	27.2	....	1.17
Total for year	19,025.0	....	660.14
May 8	215.4	4.20	9.06
" 15	213.8	4.25	9.10
" 22	215.9	4.06	8.77
" 29	236.4	3.49	8.26
June 5	211.2	4.22	8.53
" 12	227.4	3.79	8.62
" 19	222.6	3.62	8.06
" 26	214.0	3.62	7.75
July 3	199.4	3.66	7.29
" 10	201.8	3.78	7.63
" 17	190.3	3.40	6.46
" 24	194.7	3.39	6.71
" 31	179.1	3.44	6.16
Total—455 days	21,719.8	....	761.27

Late in the season the pasture was farther supplemented by green corn and other fodders as the cow required.

The behavior of this cow was radically different from that of Rosa Bonheur 5th. While the latter made most extraordinary yields, Houwtje D. maintained her flow for a much longer time. That cow is usually reckoned a good one that produces 14 pounds of butter per week for a short time, but Houwtje D. produced on an average 14 pounds of *butterfat* a week for over eight months consecutively, or from May 2, 1894, to January 2, 1895, inclusive, yielding in that 245 days 492.95 pounds of fat.

To consider the year's record of the cow in terms of butter we add one-sixth of the weight of the butterfat to itself. The 660.14 pounds of butter fat would then be equivalent to 770.16 pounds of butter. Considering 52 weeks as a year we have an average weekly yield of 14.81 pounds of butter. The largest yield of fat in seven days as shown in the table was 18.64 pounds in the week ending May 23, 1894. Again using the conversion factor as before, this should make 21.74 pounds of butter.

During the month of June, 1894, the yield of butterfat was singularly uniform, varying less than .1 of a pound of fat per week for the three weeks ending respectively June 6, 13, and 20. Thereafter the yield fell gradually and very slowly through the rest of the year.

The variations in richness as indicated by the average per cent of fat in the milk, by months was as follows:

In May the average per cent of fat was 2.88 per cent; June, 2.83 per cent; July, 2.75 per cent; August, 3.20 per cent; September, 3.35 per cent October, 3.60 per cent; November, 3.98 per cent; December, 4.09 per cent; January, 1895, 4.32 per cent; February, 4.48 per cent; March, 4.28 per cent; April, 4.24 per cent; May, 4.00 per cent; June, 3.81 per cent; July, 3.55 per cent.

The milk increased in richness as the weather grew colder in the fall and fell away again as it grew warmer in the spring.

The lapse of the period of lactation was not accompanied by a gradual and regular change in richness of the milk.

The fact that the cow was at pasture during the months immediately following the birth of the calf prevented any record being made of the food consumed until the beginning of the regular winter feeding in December, 1894. Continued cold weather did not begin until the 20th of that month, consequently the cows were not stabled until that time. In the following table are recorded the amounts of each kind of food consumed by Houwtje D. from December 20, 1894, to May 1, 1895, inclusive.

A small quantity of millet silage was fed in the latter part of January and early February. This silage was from millet cut while the seed was in the milk and preserved in a small round silo. It was very palatable and the cow ate it with avidity. The oat and pea hay was harvested when the peas were about the size commonly used for cooking. It was excellently cured and was well liked by the cows.

TABLE VII.—*Feedings stuffs consumed by Houwtje D.*

Week ending.	Roots, lbs.	Silage, lbs.	Hay, lbs.	Corn, lbs.	Oats, lbs.	Bran, lbs.	Wheat, lbs.	Millet silage.	O. P. Hay.
Dec. 26	326	317	8	30.8	18.48	48.5	35.0	----------	--------
Jan. 2	323	333	16	33.5	20.10	50.8	36.4	----------	--------
" 9	319	332	25	21.4	12.84	40.5	30.4	----------	--------
" 16	336	332	24	21.4	12.84	40.5	30.4	8	4
" 23	320	340	8	21.4	12.84	40.5	30.4	33	4
" 30	311	344	2	21.4	12.84	40.5	30.4	66	8
Feb. 6	298	346	24	21.36	12.81	40.47	30.37	66	3
" 13	231	410	32	21.36	12.81	40.47	30.36	----------	0
" 20	175	301	22	21.36	12.81	40.46	30.37	----------	16
" 27	264	345	14	21.02	12.60	40.18	30.19	----------	28
Mar. 6	250	356	19	20.00	12.00	31.87	23.13	----------	25
" 13	179	428	14	18.98	11.89	31.01	22.62	----------	28
" 20	217	290	14	18.80	10.98	30.43	22.27	----------	30
" 27	257	329	22	18.98	11.89	31.01	22.62	----------	34
April 3	302	244	21	18.98	11.89	31.01	22.62	----------	28
" 10	351	287	59	18.98	11.39	31.01	22.62	----------	--------
" 17	343	282	49	18.98	11.39	31.01	22.62	----------	--------
" 24	341	294	42	18.98	11.39	31.01	22.62	----------	--------
May 1	337	300	37	18.98	11.39	31.01	22.62	----------	--------

This table includes the feeding records for nineteen weeks or 133 days. The total amount of each food stuff consumed in that time is as follows:

Roots	5,480	pounds or	41.20	pounds	per	day.
Silage	6,060	" "	45.56	"	"	"
Hay	452	" "	3.4	"	"	"
Corn	406.16	" "	3.05	"	"	"
Oats	243 68	" "	1.83	"	"	"
Bran	702.25	" "	5.28	"	"	"
Wheat	518.03	" "	3.89	"	"	"
Millet silage	173	"				
Oat and pea hay	208	"				

This amount of fodder and grain contained 4,490.55 pounds of dry matter equivalent to 33.8 pounds of dry matter per day. Since the cow weighed on the average during the winter 1,600 pounds she had 21.12 pounds of dry matter per day per 1,000 pounds live weight. The German feeding standard for dairy cows in milk requires 24 pounds of dry matter per day per 1,000 pounds live weight.

In the next table is given the digestible protein, carbohydrates and crude fat in the average daily ration for three periods during the winter:

TABLE VIII.

	Digestible protein, lbs.	Digestible carbohydrates, lbs.	Digestible fat, lbs.	Nutritive ratio 1. to —.
December 20 to February 6	3.43	20.75	.989	6.77
February 6 to April 3	2.70	17.65	.85	7.32
April 3 to May 1	2.49	17.31	.797	7.75

The American standard for a daily ration for a cow weighing 1,600 pounds would be protein, 3.52, carbohydrates 21.28, fat 1.12 pounds. It is evident therefore that the cow was fed far less than she might reasonably have been expected to consume.

The next table gives the fat yielded, by weeks, the dry matter consumed in the same periods and the pounds of dry matter per pound of butterfat.

This record of the relation of dry matter consumed to the fat yielded is not comparable with that given for Rosa Bonheur as the latter was at the time of the test in the very beginning of the period of lactation while Houwtje D. was distant nearly a year from the birth of her last calf and was yielding the smallest amounts of fat weekly of any time during her record.

TABLE IX.

Week ending.	Fat yielded, lbs.	Dry matter consumed, lbs.	Pounds dry matter per 1 pound fat.
Dec. 26	11.68	240.91	20.62
Jan. 2	11.80	262.19	22.22
" 9	11.40	239.16	20.98
" 16	10.31	238.30	23.11
" 23	10.95	239.50	21.87
" 30	11.49	251.20	21.86
Feb. 6	11.18	265.49	23.74
" 13	10.73	271.59	25.31
" 20	10.08	222.89	22.11
" 27	11.07	266.21	24.04
Mar. 6	9.67	234.18	24.21
" 13	8.96	241.87	26.76
" 20	7.90	210.54	26.64
" 27	9.44	208.68	22.10
April 3	8.65	211.46	24.44
" 10	8.51	221.80	26.06
" 17	8.63	224.47	26.01
" 24	8.74	221.56	25.75
May 1	8.31	218.55	26.29

The total amount of fat secreted in the nineteen weeks of this winter feeding was 189.5 pounds. Assuming that wheat was worth $16.67 per ton and that the value of millet silage was the same as that of corn silage, $2.00, and oat and pea hay the same as mixed hay, $6.00 per ton, and using the values for the other ingredients of the ration that have already been taken in the record of Rosa Bonheur, the total cost for the feed during the weeks from December 19 to May 1, covered by the last table would be $29.71. The average feed cost of a pound of fat, counting no other constituent of the milk of any value, was 15.67 cents. The cow yielded in the same nineteen weeks, 4,394.6 pounds of milk of which 85 per cent, or 3,735 pounds was skim milk. Valuing the skim milk at 20 cents per hundred the quantity yielded in the nineteen weeks would be worth $7.47, leaving the net food cost of the butterfat $22.24 or 11.73 cents per pound.

In this calculation as in the similar one for Rosa Bonheur no account is made of the cost of attendance or other incidental expenses on the one hand nor of the value of the manure on the other.

On turning to pasture, May 1, 1895, the hay, roots and silage were gradually reduced and finally omitted altogether on the 7th. She was fed 12 pounds of grain daily up to the close of the record, August 1. To July 13 this 12 pounds of grain consisted of a mixture of corn, oats and bran in the proportions of 100 pounds of corn, 60 pounds of oats and 85 pounds of bran. After July 13 the ration was made up of bran and gluten meal in equal parts.

RECORD OF BELLE SARCASTIC, 23039, H. F. H. B.

Belle Sarcastic was calved January 18, 1890, and was bred by H. P. Doane, of Duffield, Genesee county, Michigan. She was sired by Sarcastic, 4729, a bull owned and bred by G. M. Shattuck, Pontiac, Mich., and out of imported pure Dutch-Friesian ancestry.

The dam was Belvisia 2d, 4553, H. F. H. B., a cow bred by Tousey & Seeley, Pontiac, Mich. She was out of Belvisia, 1675 (Dutch-Friesian Herd Book). The dam of this cow was the famous Pauline 2d (18 A. R., Vol. 1), and the sire Jelsum (81 P. R.).

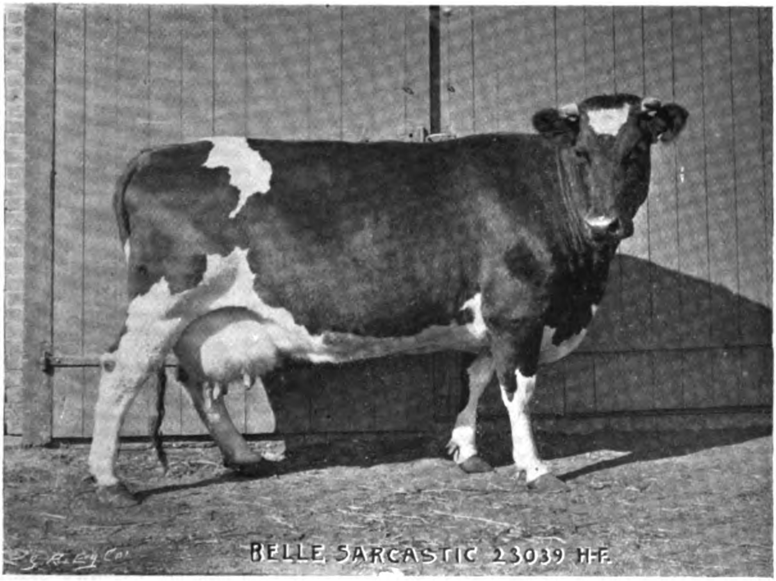
The sire of Belvisia 2d was Prince Nicolaas, 361 (Dutch-Friesian H. B.), whose dam, Marie 2d (232 M. R.), was one of the best Holstein cows ever brought into Michigan. She was selected by Cornelius Baldwin, at that time inspector for the Advanced Register of the Old Dutch-Friesian Herd Book, and was imported by T. H. McGraw, of Portsmouth, Mich. While not a coarse cow she weighed 1,900 pounds when fat. She had a wonderful development of the milk veins and gave over 90 pounds of milk in a day in the old country.

As a young heifer, Belle was decidedly beefy, broad across the shoulders and steer-like in general contour. After beginning to give milk, however, the inherited dairy temperament manifested itself until at the present time her general form approximates somewhat closely to the ideal dairy type, as is shown by her photograph.

The long head, finely chiseled, broad at the horns, strong and nervous in expression; the thin shapely neck but slightly drooping; the sharp withers, the chine straight but open and serrate; the ribs flattened and open, the loin broad and strong, with a high and level rump; the points of the thurl bones far apart and covered with a pad of fat, the thighs incurving, but strong and in good proportion, the udder large, even and with a long connection with the body extending well up behind and well forward and continued in large crooked milk veins ending in large milk wells; the skin, mellow and fine as silk, covered with a coat of soft and glossy hair; these indications point to an ideal dairy cow, capable when carefully managed of producing an extraordinary record.

In disposition she lacks the gentleness and motherly qualities of Rosa Bonheur 5th, and the tendency to stupidity of Houwtje D. She is nervous, quick, and highly sensitive, though gentle and perfectly kind to her keeper. Her weight in May and June was on the average, 1490 pounds, in November it was 1,508 pounds. During the winter it ran up very slowly to 1,600 pounds, by the latter part of April and early May, 1895. The average of her weekly weights in July, 1895, was 1,622 pounds.

Belle's first calf was dropped on the first of April, 1893, her second on the 13th of April, 1894. She did not again become pregnant until the 23d day of May, 1895. Her milk and butter record began on the 26th of April, 1894, and is given in the following table. As with Rosa Bonheur and Houwtje D., she was milked thrice daily and each mess was separately tested in duplicate by the Babcock test. The amounts given in the column of fat yields are the sums of the amounts of fat given in the three messes of the day indicated.



BELLE SARCASTIC, 23039, H. F. H. B.

RECORDS.

One day	81.9 lbs milk,	2.45 lbs fat.
Seven days	554.7 lbs milk,	16.42 lbs fat.
One year	21,075.8 lbs milk,	632.78 lbs fat.
Sixteen months	27,626.3 lbs milk,	827.22 lbs fat.

PREVIOUS RECORD.

1893, eleven months .... 9,255.5 lbs milk.

TABLE X.—*Milk and Fat Record of Belle Sarcastic.*

Week ending.	Milk, lbs.	Fat, per cent.	Fat, lbs.	Week ending.	Milk, lbs.	Fat, per cent.	Fat, lbs.
May 2	456.0	3.08	14.09	Feb. 6	326.0	3.51	11.45
" 9	504.8	2.95	14.92	" 13	338.9	3.30	11.20
" 16	535.8	2.93	15.72	" 20	336.4	3.24	10.89
" 23	549.5	2.99	16.42	" 27	360.5	3.16	11.41
" 30	549.9	2.87	15.77	Mar. 6	349.4	3.09	10.83
June 6	507.7	2.74	13.92	" 13	347.0	2.76	9.59
" 13	509.3	2.70	13.79	" 20	341.1	2.81	9.59
" 20	514.1	2.70	13.91	" 27	333.8	3.12	10.42
" 27	511.4	2.45	12.64	April 3	345.8	3.11	10.75
July 4	493.5	2.40	11.86	" 10	352.9	2.98	10.52
" 11	494.5	2.62	12.94	" 17	363.3	3.03	11.03
" 18	477.2	2.66	11.80	" 24	366.9	3.09	11.37
" 25	482.1	2.66	12.82	April 25 (1 day)	48.0	....	1.48
Aug. 1	482.8	2.57	12.43	Total for the year	21,075.8	....	632.78
" 8	442.7	2.74	12.14	May 1	358.8	3.04	10.92
" 15	444.6	2.85	12.69	" 8	360.3	3.31	11.93
" 22	462.5	2.98	13.79	" 15	359.8	3.04	10.94
" 29	439.7	2.79	12.30	" 22	393.8	2.77	10.94
Sept. 5	412.0	3.14	12.95	" 29	409.3	2.79	11.45
" 12	383.2	3.11	11.94	June 5	379.0	3.02	11.46
" 19	408.5	2.75	11.26	" 12	377.5	2.95	11.16
" 26	405.7	2.93	11.89	" 19	375.3	2.83	10.64
Oct. 3	388.8	3.21	12.48	" 26	350.7	2.94	10.34
" 10	423.8	2.94	12.45	July 3	360.2	2.97	10.71
" 17	387.6	2.85	11.04	" 10	346.7	3.09	10.72
" 24	384.4	3.07	11.80	" 17	338.5	2.97	10.07
" 31	378.6	3.25	12.29	" 24	346.7	3.06	10.63
Nov. 7	335.3	3.87	12.96	" 31	370.0	2.94	10.89
" 14	368.5	3.37	12.42	Aug. 7	374.0	2.92	10.91
" 21	360.0	3.22	11.60	" 14	371.4	2.87	10.64
" 28	336.2	3.46	11.64	" 21	373.4	2.90	10.84
Dec. 5	306.7	3.55	10.89	" 29	363.1	2.95	10.73
" 12	319.6	3.30	10.55	Total—490 days	27,626.3	....	827.22
" 19	346.8	3.16	10.96				
" 26	342.4	3.46	11.57				
Jan. 2	331.3	3.56	11.82				
" 9	346.3	3.37	11.69				
" 16	344.5	3.24	11.18				
" 23	325.4	3.37	10.99				
" 30	323.6	3.69	11.94				

The milk record for the year was 21,075.8 pounds, equivalent to an average of 57.74 pounds per day. In the 490 days she gave 27,626.3 pounds, or an average of 56.38 pounds per day.

Reducing the butterfat yields to butter, the 632.78 pounds of fat yielded in the year is equivalent to 738.24 pounds of butter. This is an average of 14.15 pounds of butter per week for the year.

The 827.22 pounds of fat given in the 70 weeks is equivalent to 965.09 pounds of butter, which is an average of 13.79 pounds of butter per week.

At the beginning of this record the cow was but four years and one-quarter old. On account of her square and beefy form she had not been selected as one of the most promising heifers of the herd and was given no unusual attention as a calf or heifer. Her previous record of 9,255.5 pounds of milk was indicative of no unusual powers. She had during the summer of 1894 good pasture and a daily grain ration of 21 pounds of the mixture of 100 pounds of corn meal, 75 pounds of oat meal and 25 pounds of bran.

Her milk flow was singularly even as to quantity and quality, considering the fact that she was a young cow and somewhat rapidly growing in weight. The average weekly yields of milk and fat and the average per cent of fat in the milk, in such periods of four or five weeks as correspond most nearly to the calendar months, are as follows:

TABLE XI.

Month.	Average weekly milk.—Lbs.	Average per cent fat.	Average weekly fat.—Lbs.
May, 5 weeks	519.2	2.96	15.38
June, 4 "	510.6	2.65	13.74
July, 4 "	486.8	2.58	12.35
Aug., 5 "	454.4	2.78	12.23
Sept., 4 "	403.3	2.98	12.01
Oct., 5 "	392.5	3.06	12.01
Nov., 4 "	362.5	3.35	12.15
Dec., 4 "	328.9	3.37	10.99
Jan., 5 "	334.2	3.44	11.52
Feb., 4 "	340.4	3.30	11.24
March, 4 "	343.8	2.94	10.11
April, 5 "	357.4	3.05	10.92
May, 4 "	380.2	2.98	11.31
June, 4 "	370.6	2.93	10.90
July, 5 "	352.4	3.01	10.60
Aug., 4 "	370.5	2.91	10.78

Belle had been turned to pasture before this record began. As the pastures dried up they were supplemented by various green fodders, oats and peas, sweet corn, and various leguminous crops. During the hottest weather and when the flies were particularly bad she was confined during the day time in a cool stable and allowed to run in a pasture at night.

Her winter feeding began December 5, the following table records the amounts of the various feed stuffs eaten during each week of the winter:

TABLE XII.

Week ending.	Roots, lbs.	Silage, lbs.	Hay, lbs.	Corn, lbs.	Oats, lbs.	Bran, lbs.	Wheat, lbs.	Millet silage.	O. P. hay.	Oil-meal.
Dec. 12	183	268	—	21.35	12.81	40.47	30.37	—	—	—
" 19	240	253	21	34.00	21.00	51.23	36.78	—	—	—
" 26	330	283	8	35.60	21.30	52.50	37.68	—	—	—
Jan. 2	307	257	16	37.00	22.00	53.32	37.68	—	4	—
" 9	315	231	—	35.60	21.30	52.50	37.68	—	31	—
" 16	332	258	—	35.60	21.30	52.50	37.68	8	24	—
" 23	318	264	—	35.60	21.30	52.50	37.68	33	12	—
" 30	247	235	—	34.50	20.70	51.64	36.96	64	10	—
Feb. 6	115	248	26	33.90	20.34	51.16	36.60	69	—	—
" 13	84	334	33	35.24	21.14	52.25	37.37	—	—	—
" 20	103	268	22	29.14	17.49	47.15	34.22	—	16	—
" 27	245	304	14	29.15	17.50	47.10	34.25	—	28	3.
Mar. 6	289	285	18	28.72	17.24	46.73	34.06	—	24	5.25
" 13	335	265	13	26.10	15.66	44.46	32.70	—	28	14.00
" 20	359	259	14	28.51	17.11	46.61	33.91	—	30	14.00
" 27	272	258	28	28.51	17.11	46.61	33.91	—	24	14.00
April 3	295	261	22	28.51	17.11	46.61	33.91	—	20	14.00
" 10	405	266	42	27.45	16.47	45.66	33.41	—	—	14.00
" 17	493	298	29	28.51	17.11	46.61	33.91	—	—	14.00
" 24	476	302	27	28.51	17.11	46.61	33.91	—	—	14.00
May 1	463	278	30	28.51	17.11	46.61	33.91	—	—	14.00

The total quantity of each of these feed stuffs eaten in the 21 weeks covered by the foregoing table, with the money value at the rates per ton already given, and the average daily consumption are as follows:

TABLE XIII.

	Pounds.	Value.	Daily ration, lbs.
Roots	6,286.	$7 76	42.76
Silage	5,670.	5 67	38.57
Hay	363.	1 19	2.47
Corn	646.01	5 84	4.39
Oats	390.21	3 12	2.65
Bran	1,020.82	7 14	6.94
Wheat	738.58	6 16	5.02
Millet silage	174.	1 74	
Oat and pea hay	257.	76	
Oil meal	120.25	1 37	
Feed cost for 147 days		$40 75	

On account of her immaturity no attempt was made to crowd the cow and the ration was kept below the standard.

The following table records the constituents of the average daily ration for four different periods during the winter:

TABLE XIV.

	Digestible protein, lbs.	Digestible carbohydrates, lbs.	Digestible crude fat, lbs.	Nutritive ratio, 1 to—
December 5 to January 9	3.021	18.65	.95	6.88
January 9 to February 20	3.105	19.95	.99	7.22
February 20 to April 3	3.578	19.90	1.06	6.3
April 3 to May 1	3.01	16.78	.905	6.22

The American standard ration would require for a cow of her weight, 1,550 pounds, 3.41 pounds of protein, 20.61 pounds of carbohydrates and 1.085 pounds of fat per day.

The cow ate her feed with avidity every day and was always vigorous, playful and perfectly healthy.

The next table gives the pounds of fat secreted by weeks during the winter, the dry matter in the food consumed for the corresponding weeks and the pounds of dry matter consumed per pound of fat yielded.

TABLE XV.

Week ending—	Fat, lbs.	Dry matter, lbs.	Pounds dry matter to 1 lb. fat.
Dec. 12	10.55	182.26	17.27
" 19	10.96	235.40	21.47
" 26	11.57	245.02	21.17
Jan. 2	11.82	248.71	21.03
" 9	11.69	250.25	21.41
" 16	11.18	256.45	22.93
" 23	10.99	256.80	23.36
" 30	11.94	250.46	20.97
Feb. 6	11.45	254.49	22.22
" 13	11.20	253.92	22.67
" 20	10.89	227.26	20.86
" 27	11.41	256.58	22.48
Mar. 6	10.83	257.68	23.79
" 13	9.59	257.31	26.82
" 20	9.59	267.14	27.85
" 27	10.42	263.34	25.27
April 3	10.75	259.18	24.11
" 10	10.52	232.63	22.11
" 17	11.03	277.04	25.11
" 24	11.37	274.59	24.15
May 1	10.92	269.47	24.68

The above table is compiled from the records of the cow at the close of the first year of this period of lactation, and when the yield of fat was the smallest per week of any time during the continuance of the record. It is not therefore comparable with a similar table given for Rosa Bonheur 5th.

The total dry matter eaten in the 21 weeks was 5,276.03 pounds equal to 35.89 pounds per day or 23.18 pounds per day per 1,000 pounds live weight, the average weight of the cow for the winter being 1,550 pounds.

The total fat yield for the 21 weeks was 230.67 pounds. There was therefore 22.87 pounds of dry matter on the average eaten for each pound of fat yielded.

The cost of the feed for the same period was $40.75. Dividing this sum by 230.67, the number of pounds of fat, we have the feed cost of one pound of fat, viz.: 17.66 cents, if no cognizance is taken of the value of the 6,120 pounds of skim milk yielded at the same time, which, at 20 cents per hundred was worth $12.24. Subtracting from the $40.75, total food cost, this value of the skim milk we have the net food cost of the fat, $28.51 or 12.35 cents per pound.

After turning to pasture in the early days of May, 1895, the grain feed was continued with some modification. To the 20th of May the daily grain feed consisted of 2 pounds of oil meal and 18 pounds of a mixture of 100 pounds of corn, 60 pounds of oats, 85 pounds of bran and 50 pounds of wheat. After May 20, the wheat was dropped and the cow received 18 pounds of corn, oats and bran in the proportions just given, with 2 pounds of oil meal. This continued until July 13, after which the daily grain feed was made up of 6 pounds of a mixture of equal parts of gluten meal and wheat bran, 12 pounds of the mixture of corn, oats and bran, and 2 pounds of oil meal.

The drouth was excessive in the early summer and the pastures were nearly an entire failure after the middle of July. The cow was therefore

shut in the stable during the heat of the day and fed on green corn and hay in addition to the grain.

She had been accustomed to receive on the average 35.89 pounds of dry matter per day while in the yard before turning to pasture. To obtain as much from pasture grass, which contains about 80 per cent of water, she would need to consume 179 pounds daily, the gathering of which alone would be a formidable undertaking even for as vigorous a cow as this one. To relieve her of the necessity of carrying such a mass of succulent material through her stomach and bowels the grain ration was kept up.

The milk flow rose toward the end of May and was fairly constant through June, July and August. The regularity as well as the unusual size of the yield is undoubtedly to be attributed to the grain feed with the pasture.

In the four months, May, June, July, and August, she consumed the following amounts of feed:

Oil meal	246	pounds,	worth	$2 80
Corn meal	758.36	"	"	7 20
Oat meal	455.50	"	"	4 56
Bran	791.40	"	"	5 54
Wheat	61	"	"	54
Gluten meal	147	"	"	1 13
Total cost of grain for four months				$21 77

The pasture throughout July and August was so poor as to form but an inconspicuous part of the ration. Counting its value with the supplementary green fodder and hay for the 123 days as $10.00 the total cost of the feed of the cow for the four months would be $31.77.

The milk yield for the same period was 6,608.5 pounds, containing 195.92 pounds of fat, equivalent to 228.57 pounds of estimated butter. Dividing the food cost, $31.77, by this amount the feed cost of a pound of butter would be 13.89 cents, without reckoning the value of the skim milk, which at 20 cents per hundred would be worth $11.23.

DAIRY FORM.

Dr. Manly Miles in his practical treatise on "Stock Breeding," (Chap. IV, first paragraph), writes concerning inheritance of acquired characters as follows:

"The habits and characteristics of animals that have been developed by the conditions in which they are placed, or the peculiar training they have received at the hands of man, appear to be transmitted from generation to generation, with nearly the same certainty and uniformity as those that characterize the original type or species from which they are descended. Some of the most striking illustrations of this form of heredity are to be found in the transmission of the highly artificial peculiarities that characterize the various improved breeds of animals. The tendency to lay on fat rapidly and to mature early is inherited in the best families of the Short-horns, the Devons, the Herefords and other meat producing breeds, while the ability to secrete an abundant supply of milk is, in like manner, perpetuated in the Ayrshires, the Jerseys, and other dairy breeds. The certainty with which these acquired qualities are transmitted constitutes one of the most valuable peculiarities of a breed."

The act of giving milk is a function of maternity. It is the effort of the dam to furnish nutriment to the offspring while it is yet incapable of securing or digesting food from other sources. The organs involved are therefore the ones most intimately associated with the development of the young before birth and the glands for secreting milk.

Where, by the art of man, the period of milk giving is lengthened and the amount yielded inordinately increased these organs must be correspondingly abnormally developed. The outflow of milk creates a draft on the energies of the body. This draft must be met by an increased food supply which in turn calls for a larger and more active stomach and bowels. Hence a good dairy cow must have a big belly.

The abnormal development of the udder and belly is accompanied by the partial suppression of the activity of those parts of the system concerned in the deposition of fat. The coöperation of these two factors has given to the dairy cow a characteristic form, easily recognizable and indicative of her value as a milk producer.

That the external form of a cow was an indication of her capabilities in the dairy was noted long ago. Professor David Low of the University of Edinburgh, Scotland, in his work "On the Domesticated Animals of the British Islands," in describing the ideal Ayrshire dairy cow of his day has this to say:

"The horns are small and curving inwards at the extremity after the manner of the Alderneys. The shoulders are light and the loins very broad and deep, which is a conformation almost always accompanying the property of yielding abundant milk. The skin is moderatly soft to the touch, the limbs are slender, the neck is small, and the head is free from coarseness. The muscles of the inner side of the thighs, technically called the twist, are thin, and the haunch frequently droops much to the rump, a character which exists likewise in the Alderney breed, and which, although it impairs the symmetry of the animal, is not regarded as incon-

sistent with the faculty of secreting milk. The udders are moderately large without being flaccid."

Of the Alderney he says: "Her neck is thin, her shoulders light, her chest narrow and the belly large. The limbs are slender, the pelvic bones prominent, the lumbar region is deep, the croup short and drooping and the udder large. The muzzle is narrow, the horns are short, slender and curving inwards."

The author recognized these characters of form as necessarily going with the faculty of milk giving and as being the opposite of the ones required in a beef animal. (See also Fleischmann, Lehrbuck der Milchwirthschaft, page 50, edition of 1893.)

In later times, in text books and the agricultural press, the broad differences between the beef and dairy types have been much magnified and it has grown to be a fixed belief among dairymen that those cows alone can be depended on for a profitable yield of milk and butter fat, whose forms correspond somewhat closely with this dairy type.

In selecting foundation animals for the herd, therefore, the tentative opinion as to the value of a given animal is founded on her appearance, while the final decision is based upon the data furnished by the scales and Babcock test. A suggestion as to the relative importance to be attached to the size and other qualities of the different parts of the anatomy of the cow as judged by the eye and hand may be drawn from the copy of the scale of points for dairy cows in use at the Michigan Agricultural College given below with the scores of Rosa Bonheur, Houwtje D. and Belle Sarcastic.

DEPARTMENT OF PRACTICAL AGRICULTURE.

MICHIGAN AGRICULTURAL COLLEGE.

Score Card B.—Dairy Cows.

Scale of points.	Perfect.	Rosa Bonheur.	Houwtje D.	Belle Sarcastic.
GENERAL APPEARANCE:				
Age, estimated ....; corrected, ...				
Weight, estimated, ... lbs.; corrected, ... lbs.				
Form, wedge-shaped, viewed from front, side and above..............	8	8	6.5	7.5
Quality, hair fine; skin soft; medium thickness; bone clean..........	7	6	6.5	7
Temperament, nervous..	4	4	3.5	4
HEAD:				
Muzzle, clean cut; mouth large; nostrils large; face lean, long and dishing..............................	1	1	1	1
Eyes, full, mild, bright..	2	2	1.5	2
Forehead, broad..	2	2	1.5	2
Ears, medium size, fine texture....................................	1	1	1	1
Horn, small at base..	1	1	1	1
FOREQUARTER:				
Neck, thin, medium length..	2	2	2	2
Withers, lean, sharp..	2	2	1	2
Shoulders, light, oblique..	2	2	2	2
Legs, short, straight, clean boned..................................	1	1	1	1
BODY:				
Brisket, thin, sharp..	1	1	1	1
Chest, deep through lungs, girth large ...... ft. ...... ins.	8	8	7	8
Ribs, well sprung, broad, far apart................................	3	3	3	3
Belly, large, roomy..	7	7	7	7
Chine, large, prominent, open......................................	1	1	.5	1
Back, high, lean..	1	1	.9	1
Loin, broad..	2	2	2	2
Flank, deep..	1	1	1	1
Navel, large..	2	2	2	2
HINDQUARTERS:				
Hips, wide apart..	2	2	2	2
Rump, long and high..	2	2	2	1.5
Pin bones or thurls, high, wide apart..............................	1	1	1	1
Thigh, thin, incurving..	4	4	4	3
Tail, fine, reaching hock..	1	1	1	1
Escutcheon, spreading and high....................................	1	1	1	.5
Udder, long, not fleshy, attached high; quarters even..............	17	17	15.5	17
Teats, large, evenly placed..	5	5	5	5
Milk veins, large, tortuous, branching............................	4	4	4	4
Milk wells, large..	3	3	3	3
Legs, short, clean boned, far apart................................	1	1	1	1
Total..	100	99	92.4	97.5

Name of animal.. **Owner**..

Date.. **Student's name**..

Standing..

It is evident that the study of the dairy form takes no cognizance of breed, and no division of cows into dairy and beef animals is or can be made along breed lines. The basal proposition on which the theory and practice of cow selection by means of the form is based, is, that a cow with special powers in the dairy line will necessarily develop a dairy form

just as a cow, with special excellence as a beef animal develops a properly built frame whereon to lay her flesh and fat and must necessarily assume the plump and rectangular form which distinguishes that class of animals.

A cow whether Shorthorn, Hereford or Jersey that gives but a small amount of milk, and that for a short time, needs but a small udder, while a cow that yields a hundred pounds a day must have both a large reservoir to hold the milk and milk glands sufficiently developed to secrete it. Between these two extremes all gradations exist.

The organ therefore to which the greatest importance is attached and in which the greatest differentiation may be expected is the udder. To conform perfectly to the standard it should have a long connection with the body, extending well forward under the belly and be continued with loose skin well up behind. The front quarters should be of the same size as the hind ones and should hang to the same level. For the sake of ease of milking the teats should be of good size and be evenly placed.

The cows whose scores have just been given, differ somewhat in the character of their udders. While Rosa's udder is of enormous size as already stated, extends well forward and well up behind, is even, and neither meaty nor flaccid, that of Houwtje D. is decidedly deficient in the forequarters, and Belle's does not extend as far up behind as the standard would lead us to desire. In each case the feeling of the udder is such as to indicate the highest development of glandular structure of the organ. At first sight the three udders would be called "meaty" but careful inspection shows the presence of the needed gland free from fat. Closely connected with the udder are the "milk veins" so called. In each of the three cows these veins are very large, crooked, and long and enter the body through large holes easily felt on the under side of the abdomen.

After the udder the size of the belly is the point of greatest importance. The three cows are well provided with immense paunches and excellent digestive organs as is evidenced by the large rations they have consumed, the avidity with which the food has been eaten, and the universal freedom from indigestion or other ailment.

The magnitude of the udder and belly give these cows the wedge shape as viewed from the side.

The girths of the chest, loin, and belly of the three cows described above, and of four cows of a decided beef type are as follows:

TABLE XVI.

Cow.	Heart, girth.		Loin, girth.		Belly, girth.		Difference, heart and loin, inches.	Difference, heart and belly, inches.	Width between eyes, inches.	Length of head, inches.
	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.				
Rosa Bonheur	7	......	7	10	8	6	10	18	8.5	24
Houwtje D.	6	11	7	10	8	5	11	18	8.5	22
Belle Sarcastic	6	11	8	1	8	8	14	19	8.5	19.5
Victoria C.	6	11	7	10.5	8	8.5	11.5	16.5	8.5	19
Mysie 4th	6	7.5	7	5	7	11.5	9.5	16	6.75	17
Mysie 3d	6	7.5	7	5	7	11.5	9.5	16	7.5	17
Mysie 44th	6	9.5	7	7	8	1.5	9.5	16	7.5	17

A large girth behind the shoulders is as important as a large belly. To do the work involved in the digestion and assimilation of the requisite food and the secretion of the milk for a large butter yield the system of the cow must have an abundant supply of oxygen and great lung capacity, combined with size and activity of the other thoracic organs. The wedge shape of the dairy cow must not be due to any constriction of the form at this point but to extra development of the belly and udder.

Next in importance as a guide to the value of the cow come the indications of perfect health and good quality in the fine and glossy coat of hair and the mellow skin. Experience is necessary either to recognize the presence of these indications or appreciate their importance.

In most of the minor details the forms of the three cows correspond very closely with the standard although in one important respect they differ from the generally accepted model. They are not poor in flesh and emaciated.

The excellent working order of the digestive and assimilating organs and the sufficiency of the food supply are manifested not only by the yield but by the slick and glossy coat of hair and good covering of flesh they carry. It has never been demonstrated that emaciation is a necessary accompaniment of the highest and most economical milk and butter yield.

It seems to be rather an evidence of constitutional or temporary ill health. A cow is rightly said to be "out of condition" when her coat is rough, her skin tight, and her general appearance poor, emaciated and unthrifty. A good milk cow is a healthy cow, and to be healthy a cow must have her internal organs in such a state of activity as to make her sleek, thrifty and vigorous in appearance. She should not be fat on the one hand nor cadaverous on the other. It is a significant fact in this connection that Belle gained in weight from 1,450 pounds to 1,622 pounds while making the record given, and that she is in full flesh with somewhat beefy thighs.

At best, the examination of the forms of the cows should but sort out the ones to be afterwards tried by the scales and test. The score card rightly used is an aid to the judgment, of the beginner at least, but cannot take the place of skill acquired by experience nor of the scales and test. Where two cows conform in the most important points to the dairy type as expressed by the score card, a difference of a few points in the total score can not be regarded as indicating which of the cows will give the larger yield or secure it with the greater economy.

VARIATION IN QUALITY OF MILK.

The individuality of the cow is the chief factor in determining the richness of her milk. She is influenced in the matter by other causes and may vary the quality of her milk from time to time by reason of them, but the dominance of her own individuality is so paramount that the other factors are relatively of but little importance. If the dairyman desires richness in fat rather than quantity of milk he can better attain his end by selecting cows whose milk tests high, rather than by attempting by any system of feeding and care to increase the per cent of fat in cows whose milk is naturally poor. The quality of the milk is a characteristic, permanently fixed at birth for each cow and one that is susceptible to modification within narrow limits only.

One of the influences affecting the quality of the milk is the lapse of the period of lactation. It has been assumed that there is a gradual increase in the per cent of fat in the milk from the birth of the calf until the cow goes dry. This belief is not borne out by the records of these three cows nor by similar records of other cows in our own herd or elsewhere. Other conditions, more potent apparently, interfere, and the result is often that the milk grows poorer for several months after calving and becomes richer later, either gradually or somewhat suddenly. The records already given sufficiently illustrate this point.

The three cows gave richer milk in the winter months than in the summer, as was shown by the statements of the average monthly per cent of fat in the records of each cow.

The reports of the Geneva, New York, station, give among others the yearly records of seven cows calving in the fall. Here the same fact is apparent. The average per cent of fat of the seven cows by months was as follows: December, 4.96 per cent; January, 4.53 per cent; February, 4.38 per cent; March, 4.51 per cent; April, 4.61 per cent; May, 4.47 per cent; June, 4.35 per cent; July, 4.27 per cent; August, 4.36 per cent; September, 4.75 per cent; October, 4.88 per cent; November, 5.03 per cent; December, 5.27 per cent.

This variation in the per cent of fat seems to be due very largely to the seasonal variation in temperature and other meteorological conditions, as there was no radical changes in feeding coincident with the changes in the richness of the milk.

A review of the records of the other cows of the college herd shows in the majority of cases a similar relation between the temperature and the per cent of fat in the milk. Almost invariably the milk is richer in cold weather regardless of the lapse of the period of lactation. The frequent and often radical changes in per cent of fat between consecutive weeks noted in the records of each of the cows can not be attributed to changes in feed, temperature or other known condition of environment but are due to causes not yet explained.

The recurrence of the period of heat sometimes caused an increase in the per cent of fat and sometimes the reverse. The quantity of milk secreted at these times also fluctuated irregularly, but no rule applicable to the three cows could be deduced.

A study of the quantities of milk drawn from Rosa Bonheur 5th in the morning, at noon and in the evening gives us the next table. It must be remembered that the interval between the consecutive milkings was the same viz.: eight hours.

TABLE XVI.

Morning.			Noon.			Night.		
Milk, lbs.	Fat, per cent.	Fat, lbs.	Milk, lbs.	Fat, per cent.	Fat, lbs.	Milk, lbs.	Fat, per cent.	Fat, lbs.
36.33	2.50	.908	32.85	2.93	.963	31.33	2.86	.90
33.14	2.64	.875	30.40	3.10	.945	30.44	2.87	.872
26.20	2.66	.71	24.88	2.79	.692	22.19	2.62	.58

The table embraces the 67 days next after the beginning of the record on the 20th of February and is divided into three periods, two of 22 days duration and the third of 23 days. In the appropriate columns are given the average weight of the mess of milk yielded, the per cent of fat and the average amount of fat for the morning, noon and night milkings respectively.

The milk was the richest in fat at the noon milking on the average for each of these three periods and the poorest in the morning.

The absolute amount of fat was also greatest at noon and about equal in the morning and evening, while the yield of milk was almost invariably greatest in the morning.

Belle Sarcastic gave the richest milk in the noon mess and the poorest in the morning, while the largest absolute yields of fat were found in the morning mess as the average of 39 days. The figures are as follows: Morning, 26.189 pounds milk, 2.812 per cent fat, .73 pounds fat; noon, 23.49 pounds milk, 3.17 per cent fat, .703 pounds fat; night, 22.44 pounds milk, 2.94 per cent fat, .668 pounds fat.

Houwtje D. gave both the richest milk and the greatest amount of fat at night. The averages for 39 days are as follows: Morning, 28.87 pounds milk, 2.71 per cent fat, .81 pounds butter fat; noon, 25.98 pounds milk, 2.835 per cent fat, .808 pounds fat; night, 27.62 pounds milk, 3.05 per cent fat, .847 pounds fat.

The question then as to when a cow gives the richest milk or the greatest quantity of fat rests entirely on the individuality of the cow.

FEEDING SUGGESTIONS.

Soon after Rosa Bonheur calved in February, 1894, it became evident that she was capable of producing an unusual yield of milk. It was determined therefore to feed her to her utmost limit. She responded with the records given. These show that, given the proper machine in the shape of a cow and the proper feed and care, it is possible to produce over one hundred pounds of milk per day for seventeen consecutive days. They show farther that it is possible to produce from a single cow, an average of 19.42 pounds of butter fat or 22.65 pounds of butter per week for six consecutive weeks in the extreme cold weather of winter and the varying temperatures of early spring. They show farther that such production can be made without loss of weight on the part of the cow and with an average expenditure of but 19.71 pounds of dry matter for each pound of fat.

Her feeding record, however, cannot be taken as a model for other cows. It represents simply her tastes and the uppermost limits of her appetite and capacity.

The feeding of Houwtje D. and Belle Sarcastic was done on a different plan. No attempt was made to secure phenomenal yields, but simply the development of the cows and the economical production of milk and butter. The feed stuffs used were such as are easily obtainable on ordinary Michigan farms. They were prepared and fed in such a way as to be attractive to the appetites of the cows. As great a variety of the several classes of feeding stuffs as possible was provided; for succulent fodders, silage and roots; for rough fodder, mixed hay and oats and peas and a variety of grains and by-products for the concentrated feed.

To tempt her appetite the feed of a cow must be of a kind acceptable to her and be presented in a form that she likes. Succulence and variety are two important elements of palatability. The mangers of the cows were kept scrupulously clean and they were never fed to excess leaving anything to ferment in the feeding boxes. The silage was from dent corn, nicely glazed when harvested, cut rapidly into the silo and well packed, covered with cut straw, but not weighted. It was sweet and free from mould and in excellent condition when fed. The cows were very fond of it. Nevertheless to afford greater variety to the ration one-half of the succulent part was made up of roots. The average daily ration of Houwtje D. contained 45.56 pounds of silage and 41.20 pounds of mangels, while that of Belle Sarcastic had but 38.57 pounds of silage with 52.76 pounds of mangels. Whether the dry matter of silage is equal in value to the dry matter of roots is not of so much importance from a practical point of view as the fact that the cows were very fond of both and the variety of succulent feeds gave added palatability to the ration. There would have been also vastly more danger of overfeeding if either had been fed alone as the succulent feed than was the case when they were fed together. The stomach of the cow rebels against an excess of any one fodder.

The chief advantage of silage over the same field area of corn, field cured, seems to lie in its greater palatability.

In the winter the cows were kept in box stalls. These stalls, while affording protection from the wind and storms were well ventilated. The temperature on cold nights dropped considerably below the freezing point. Plenty of straw was used for bedding. The cows were watered three or more times daily, going to the trough in the barnyard except on the days when cold snow storms were raging. They were allowed exercise in the yard every day except in the coldest weather and stormy days.

The utmost regularity prevailed as to time and manner of milking.

SUMMARY.

The records of the three cows seem to warrant the following suggestions:

1. The similarity between the forms of these cows and the ideal dairy type as exemplified in the score card goes far to confirm the value of the latter.

2. The size of the udders and bellies requisite to the production of extraordinary yields seems to indicate that the cows must be relatively large if a phenomenal record is desired.

3. Perfect health, a glossy coat, thrifty appearance and a good coat of flesh are not incompatible with the best and most economical dairy performance.

4. In feeding dairy cows successfully they must be treated as individuals, each with likes and dislikes peculiar to herself. "One cow's meat" may be "another's poison."

5. Regard must be had to the same question of individuality in the stable management. Rosa enjoyed a temperature entirely too low for the comfort of the other cows in the herd.

6. Cows should be given a variety of feeds.

7. They should be allowed an abundance of succulent food in winter.

8. In these cases an ample grain ration while at pasture was accompanied by extraordinary yields. It hardly seems possible that the latter could have been produced without the former.

9. The individuality of the cow is the determining factor, (a) in the amount of milk she can be made to yield; (b) in the quality of her milk; (c) in the relation of quantity and quality to the lapse of the period of lactation; (d) in the selection of her feed; (e) in her stable management as to temperature, frequency of feeding and watering.

10. While the richness of the milk in fat is largely determined by the individuality of the cow herself it is influenced within narrow limits by the season, the richer milk being yielded in the colder months.

11. The fact that each of these cows descended from ancestors of merit confirms the idea that ability in the dairy is a matter of inheritance and that therefore in the selection of his cows the dairyman should regard (a) their forms, (b) the performance of their ancestors and (c) their record with scales and test. The latter is the deciding factor.

12. In feeding, the general plan should be to place the cows in the hands of an experienced and skillful feeder, and then provide an abundance of succulent feed, a variety of grains and hay, and insist that these materials shall be presented in the most appetizing form. The judgment of the feeder rather than any predetermined formula must decide what the ration of each cow shall be both in amount and composition. This judgment will be governed largely by the appetite of the cow and the conditions of her bowels and milk glands, but will attach due weight to the knowledge of the chemical constitution and specific effect of each element of the ration.

MICHIGAN AGRICULTURAL COLLEGE,
EXPERIMENT STATION,
September 1, 1895.

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FATTENING LAMBS.

BY F. B. MUMFORD.

CONTENTS.

Experiments with fattening lambs have been conducted at this station for several seasons for the purpose of investigating some of the methods of feeding in general use among the farmers of the State. The commercial aspect of the subject has been kept prominently in sight and every effort has been put forth to surround our animals with conditions similar to those existing on the farms of Michigan. The prime object of these experiments has been to investigate subjects of direct interest to those engaged in the business of fattening lambs for the eastern markets. The experiments may be generally classified as follows: 1. Comparative tests of grain rations. 2. Different methods of feeding. 3. The value of supplementary fodders. 4. The comparative value of various coarse fodders. Corn has formed the basis of the great majority of the grain rations investigated, as it does of most of the rations of the successful feeders of the State. Other grains and by-products fed were wheat, oats, bran and oil meal. Some of the rations consisted of one grain only, while others were made up of various combinations. The uniform coarse fodder throughout the series has been a good quality of clover hay.

Great care has been taken to select animals for each series that were uniform in size, age and breeding. The animals used were half-blood Hampshire lambs in reasonably good condition and were purchased of farmers in the neighborhood of the college. They were received during the first week of October and were immediately turned upon a twelve acre

field of rape. They pastured upon this until November 12, 1894, when they were placed in the barn and fed a light grain ration of bran and oats until November 25, when the experiment proper began. They were divided into eight lots, taking care that no lot should have the advantage of others in gross weight, general thrift or condition.

The animals were confined in our experimental feeding barn and were treated alike in all respects, except as noted. The feeding barn is conveniently arranged with an alley extending along one end of all the pens. In this alley is located a set of bullock scales so that none of the animals, with the exception of lot one, were allowed to run outside of the barn at any time during the experiment. A large window in each pen opening directly to the outside air gave an easy and convenient means of ventilation. These windows were kept open at all times except during severe and driving storms. No effort was made to protect any of the pens from the cold which might enter at these opened windows except as noted below in case of lot five. Water was supplied from a hydrant in the building.

GENERAL PLAN OF EXPERIMENT.

Eighty lambs of uniform size, condition and breeding were selected. They were divided into eight equal lots and placed in pens numbered from one to eight inclusive. These feeding pens, as before described, were so situated that the conditions surrounding the several lots were as nearly alike as it is possible to have them in such experiments. For about one week preceding the beginning of the experiment all the lambs were fed on a light grain ration consisting of bran and oats and a fodder ration of clover hay. After the experiment proper began, the food and water furnished at each feeding was carefully weighed, and the weights recorded on blanks made for the purpose. The temperature of the pens was taken three times each day. The feeding was done regularly at seven o'clock in the morning and three thirty in the afternoon, always in the same order, i. e., lot one was first supplied and the others in turn, finishing with lot eight.

The live weights were taken once each week on Monday morning at eight o'clock, after having received a known amount of grain and before being supplied with either hay or water. In this way we were able to overcome, to a large extent at least, the inaccurate and unsatisfactory results arising from a variation in the bowel contents. The scales were located at one end of the feeding alley and we were fortunate in being able to secure the weights of the animals with the minimum amount of confusion and excitement incident to such occasions. The experiment lasted for a period of thirteen weeks.

FOOD STUFFS.

The corn was of the Dent variety and was grown on the college farm, except a small amount of western corn purchased for completing the experiment. In every case where corn is indicated as a part of the grain ration it means whole shelled corn.

The wheat was also produced on the college farm and was of the White Clawson variety and always fed whole.

The sugar beets were of the French White Sugar variety, somewhat smaller than we are accustomed to produce and a small per cent of them had been slightly injured by frost. They were sliced before feeding.

The oats and bran were of the usual quality of such materials to be obtained in the State.

The clover hay was of a uniform quality, bright, clean, well cured and of medium fineness.

Cost of Food Stuffs.

Corn	$19 00	per ton.
Wheat	17 83	" "
Oats	20 00	" "
Bran	14 00	" "
Sugar Beets	2 50	" "
Clover Hay	6 00	" "

WEEKLY RECORDS OF FOOD, WEIGHTS AND GAINS.

The tables for each lot show the consumption of food for each week, the water drank, the total and average live weight at the end of the weekly period and the average weekly gain for one sheep during one week. The weights of grain, hay and water have been compiled from our daily records. The weekly records are summed up at the bottom of the table and include the total amounts of food consumed and the gains made for the entire period of thirteen weeks. One of the most notable points in connection with these tables appears in the column of average weekly gains. Certain weeks seem to be favorable for large gains in all the lots, while other weeks are as uniformly accompanied by very small gains and sometimes losses. In previous experiments we have observed that low temperatures were generally favorable to large gains and that the small gains were usually made during the weeks showing the highest temperatures. These conditions do not explain the variations observed in this experiment. There are apparently influences stronger even than food itself and more attention should be given to this variation for the purpose of discovering if possible the favorable conditions for rapid and uniform gains.

FINANCIAL STATEMENT.

The financial statements do not indicate the real profit arising from the transactions involved. They merely contain a statement of the first cost, the cost of food and the gross receipts. No account whatever is made of the interest on the money invested nor the cost of attendance. On the other hand the lambs have not been credited with the value of the manure produced which, estimated at current rates for commercial fertilizers, would amount to a very considerable item.

LOT 1. (10 Lambs.)

Weekly record of feed, weight and gain. (Grain ration—Corn and wheat.)

Dates.	Corn and wheat.	Clover hay.	Water.	Total weight.	Total gain.	Average weight.	Avg. weekly gain.
November 25				855		85.5	
December 2	57	94	164.5	855	00	85.5	0
" 9	82.5	92	186.5	878	23	87.8	2.3
" 16	102.0	73	163.5	903	25	90.3	2.5
" 23	75.5	75	149.0	900	-3	90.0	-.3
" 30	105.5	76	143.5	926	26	92.6	2.6
January 6	101.0	83	114.5	944	18	94.4	1.8
" 13	97.5	87	110.0	973	29	97.3	2.9
" 20	100.5	84	54.5	988	15	98.8	1.5
" 27	104.5	84	60.5	1,010	22	101.0	2.2
February 3	88.5	84	45.5	1,033	23	103.3	2.3
" 10	104.0	87	8.5	1,042	9	104.2	.9
" 17	87.0	84	7.0	1,057	15	105.7	1.5
" 24	90.5	84	20.0	1,060	3	106.0	.3
Totals	**1196.0**	**1,087**	**1228.0**		**205**		

FINANCIAL STATEMENT.

Lot 1. (10 lambs.)

DEBIT.

To 10 lambs, 855 lbs. @ 2.4 cts.	$20 52
To feed as follows:	
598 lbs. corn @ $19 per ton	5 68
598 lbs. wheat @ $17.83 per ton	5 33
1,087 lbs. hay @ $6 per ton	3 26
Total expenditures	$34 79

CREDIT.

By 10 lambs, 1,060 lbs. @ $5 per cwt.	$53 00
Profit on one lamb	$1 82

LOT 2. (10 Lambs.)

Weekly record of feed, weight and gain. (Grain ration—Corn and wheat.)

Dates.	Corn and wheat.	Clover hay.	Water.	Total weight.	Total gain.	Average weight.	Avg. weekly gain.
November 25				851		85.1	
December 2	57	99	222	872	21	87.2	2.1
" 9	82.5	106	213	890	18	89.0	1.8
" 16	99.5	84	199	916	26	91.6	2.6
" 23	81.0	90	181.5	930	14	93.0	1.4
" 30	102.5	87	154.5	947	17	94.7	1.7
January 6	92.5	84	158.0	964	17	96.4	1.7
" 13	89.0	88	138.0	970	6	97.0	.6
" 20	90.0	89	134.0	996	26	99.6	2.6
" 27	100.0	84	130.0	1,013	17	101.3	1.7
February 3	99.5	89	135.0	1,034	21	103.4	2.1
" 10	94.5	87	85.0	1,026	-8	102.6	-.8
" 17	84.5	88	144.5	1,056	30	105.6	3.0
" 24	91.5	98	179.0	1,081	25	108.1	2.5
Totals	**1164.0**	**1,178**	**2078.5**		**230**		

FINANCIAL STATEMENT.

Lot 2. (10 lambs.)

DEBIT.

To 10 lambs, 851 lbs. @ 2.4 cts.	$20 42
To feed as follows:	
582 lbs. corn @ $19 per ton	5 53
582 lbs. wheat @ $17.83 per ton	5 19
1,173 lbs. hay @ $6 per ton	3 52
Total expenditures	$34 66

CREDIT.

By 10 lambs, 1081 lbs. @ $5 per cwt.	$54 05
Profit on one lamb	$1 94

LOT 3. (10 Lambs.)

Weekly record of feed, weight and gain. (Grain ration—Corn.)

Dates.	Corn.	Clover hay.	Water.	Total weight.	Total gain.	Average weight.	Avg. weekly gain.
November 25				851		85.1	
December 2	57	99	166	876	25	87.6	2.5
" 9	82.5	106	200	892	16	89.2	1.6
" 16	104.5	84	191	920	28	92.0	2.8
" 23	111.5	81	211	947	27	94.7	2.7
" 30	94.5	79	149	951	4	95.1	.4
January 6	84.0	85	130.5	968	17	96.8	1.7
" 13	98.0	90	142.5	984	16	98.4	1.6
" 20	103.5	84	133.5	1,007	23	100.7	2.3
" 27	106.0	84	132.0	1,027	20	102.7	2.0
February 3	106.5	89	129.5	1,043	16	104.3	1.6
" 10	98.5	86	91.5	1,052	9	105.2	.9
" 17	85.5	89	142.5	1,086	34	108.6	3.4
" 24	76.0	86	126.5	1,084	-2	108.4	-.2
Totals	**1,208**	**1,142**	**1,945.5**		**233**		

FINANCIAL STATEMENT.

Lot 3. (10 lambs.)

DEBIT.

To 10 lambs, 851 lbs. @ 2.4 cts.	$20 42
To feed as follows:	
1,208 lbs. corn @ $19 per ton	11 48
1,142 lbs. hay @ $6 per ton	3 43
Total expenditures	35 33

CREDIT.

By 10 lambs, 1,084 lbs. @ $5 per cwt.	$54 00
Profit on one lamb	$1 86

LOT 4. (10 Lambs.)

Weekly record of feed, weight and gain. (Grain ration—Wheat.)

Dates.	Wheat.	Clover hay.	Water.	Total weight.	Total gain.	Average weight.	Avg. weekly gain.
November 25				845		84.5	
December 2	57	99	188.5	861	16	86.1	1.6
" 9	82.5	106	227.5	878	17	87.8	1.7
" 16	88.5	83	222.5	907	29	90.7	2.9
" 23	78.0	86	195.0	904	-3	90.4	-.3
" 30	105.5	87	168.0	923	19	92.3	1.9
January 6	99.0	86	180.0	943	20	94.3	2.0
" 13	100.0	96	164.0	967	24	96.7	2.4
" 20	91.5	86	147.5	975	8	97.5	.8
" 27	105.0	97	182.0	1,002	27	100.2	2.7
February 3	106.5	98	155.0	1,040	38	104.0	3.8
" 10	107.0	91	115.0	1,041	1	104.1	.1
" 17	87.0	89	188.0	1,062	21	106.2	2 1
" 24	93.5	95	161.0	1,062	00	106.2	0.0
Totals	**1,201**	**1,199**	**2,294**		**217**		

FINANCIAL STATEMENT.

Lot 4. (10 lambs.)

DEBIT.

To 10 lambs, 845 lbs., at 2.4 cts.	$20 28
To feed as follows:	
1,201 lbs. wheat, at $17.83 per ton	10 71
1,199 lbs. hay, at $6.00 per ton	3 60
Total expenditures	$34 59

CREDIT.

By 10 lambs, 1,062 lbs., at $5.00 per cwt.	$53 10
Profit on 1 lamb	$1 85

LOT 5. (10 Lambs.)—*Shorn in fall.*

Weekly record of feed, weight and gain. (Grain ration—Corn and wheat.)

Dates.	Corn and wheat.	Clover hay.	Water.	Total weight.	Total gain.	Average weight.	Avg. weekly gain.
November 25				839		83.9	
December 2	57	99	197	833	-6	83.3	-.6
" 9	82.5	99	115.5	793	-40	79.3	-4.0
" 16	104.5	84	166.5	842	49	84.2	4.9
" 23	122.0	104	167.5	890	48	89.0	4.8
" 30	106.5	87	117.5	884	-6	88.4	-.6
January 6	102.5	98	151.5	918	34	91.8	3.4
" 13	104.5	109	125.0	932	14	93.2	1.4
" 20	107.0	112	161.5	964	32	96.4	3.2
" 27	105.0	112	127.0	948	-16	94.8	-1.6
February 3	106.0	112	129.5	994	46	99.4	4.6
" 10	96.5	105	77.0	970	-24	97.0	-2.4
" 17	83.5	112	168.0	1,014	44	101.4	4.4
" 24	88.5	103	145.0	1,000	-14	100.0	-1.4
Totals	**1266**	**1,336**	**1848.5**		**161**		

FINANCIAL STATEMENT.

Lot 5 (10 Lambs).

DEBIT.

To 10 lambs, 839 lbs., at 2.4 cts.	$20 14
To shearing 10 lambs	80
To feed as follows:	
633 lbs. corn at $19.00 per ton	6 01
633 lbs. wheat at $17.83 per ton	5 64
1,336 lbs. hay at $6.00 per ton	4 01
Total expenditures	$36 60

CREDIT.

By 10 lambs, 1,000 lbs., at $4.00 per cwt.	$40 00
By wool, 47 lbs., at 15 cts.	7 05
Total receipts	$47 05
Profit on one lamb	$1 05

LOT 6. (10 Lambs.)

Weekly record of feed, weight and gain. (Entire grain ration replaced by sugar beets.)

Dates.	Sugar beets.	Clover hay.	Water.	Total weight.	Total gain.	Average weight.	Avg. weekly gain.
November 25				835		83.5	
December 2	171	90	100	829	-6	82.9	-.6
" 9	243	95	59	823	-6	82.3	-.6
" 16	400	82	23	833	10	83.3	1.0
" 23	455	97	32	842	9	84.2	.9
" 30	496	85	12	849	7	84.9	.7
January 6	490	84	7.5	861	12	86.1	1.2
" 13	490	88	20.5	873	12	87.3	1.2
" 20	490	84	18.0	890	17	89.0	1 7
" 27	490	84	15.5	905	15	90.5	1.5
February 3	490	98	13.0	911	6	91.1	.6
" 10	490	98	13.5	937	26	93 7	2.6
" 17	490	98	23.5	945	8	94.5	.8
" 24	490	98	27.0	951	6	95.1	.6
Totals	**5,685**	**1,181**	**364.5**		**116**		

FINANCIAL STATEMENT.

Lot 6. (10 lambs.)

DEBIT.

To 10 lambs, 835 lbs. @ 2.4 cts.	$20 04
To feed as follows—	
5,685 lbs. sugar beets @ $2.50 per ton	7 11
1,181 lbs. hay @ $6 per ton	3 54
Total expenditures	$30 69

CREDIT.

By 10 lambs, 951 lbs. @ $5 per cwt.	$47 55
Profit on one lamb	$1 69

LOT 7. (10 Lambs.)—*Self feed.*

Weekly record of feed, weight and gain. (Grain ration—Corn, wheat, oats and bran.)

Dates.	Corn.	Wheat.	Oats.	Bran.	Clover hay.	Water.	Total weight.	Total gain.	Average weight.	Avg. weekly gain.
November 25							853		85.3	
December 2	19	19	19	19	99	219	890	37	89.0	3.7
" 9	28	27	33	23	81	229	892	2	89.2	.2
" 16	41	17	44	9	69	243.5	902	10	90.2	1.0
" 23	35	17	24	13	70	163.5	906	4	90.6	.4
" 30	40	5	35	40	70	191.5	933	27	93 3	2.7
January 6	35	10	24	50	60	195.5	951	18	95.1	1.8
" 13	47	6.5	13	60	69	204.0	963	12	96.3	1.2
" 20	46	9.0	6	49	70	203.5	992	29	99.2	2.9
" 27	59	15.5	8	42	62	180	995	3	99.5	.3
February 3	50	13	10	53	70	196	1,023	28	102.3	2.8
" 10	53	16	8	37	64	127	1,011	-12	101.1	-1.2
" 17	47	15	16	36	70	210	1,061	50	106.1	5.0
" 24	56	19	7	36	70	185	1,059	-2	105.9	-.2
Totals	**556**	**189**	**247**	**467**	**924**	**2547.5**		**206**		

FINANCIAL STATEMENT.

Lot 7. (10 Lambs.)

DEBIT.

To 10 lambs, 853 lbs. @ 2.4 cts.	$20 47
To feed as follows:	
556 lbs. corn @ $19 00 per ton	5 28
189 lbs. wheat @ $17.83 per ton	1 68
247 lbs. oats @ $20.00 per ton	2 47
467 lbs. bran @ $14.00 per ton	3 27
924 lbs. hay at $6.00 per ton	2 77
Total expenditures	$35 94

CREDIT.

By 10 lambs, 1,059 lbs. @ $5.00 per cwt.	$52 95
Profit on 1 lamb	$1 70

LOT 8. (10 Lambs.)

Weekly record of feed, weight and gain. (Grain ration--Corn and wheat.)

Dates.	Corn and wheat.	Clover hay.	Water.	Total weight.	Total gain.	Average weight.	Avg. weekly gain.
November 25				799		79.9	
December 2	57	99	181.5	812	13	81.2	1.3
" 9	82.5	106	210.5	832	20	83.2	2.0
" 16	104.5	84	209.5	848	16	84.8	1.6
" 23	83.0	89	206.0	873	25	87.3	2.5
" 30	107.0	89	166.5	890	17	89.0	1.7
January 6	99.5	98	182.0	918	28	91.8	2.8
" 13	99.5	98	163.0	938	20	93.8	2.0
" 20	100.5	89	156.5	960	22	96.0	2 2
" 27	105.0	87	132.5	977	17	97.7	1.7
February 3	108.5	93	162.5	1,016	39	101.6	3.9
" 10	107	91	82.5	1,003	-13	100.3	-1.3
" 17	85	88	165.0	1,036	33	103.6	3.3
" 24	94	98	173.0	1,048	12	104.8	1.2
Totals	**1,282**	**1,209**	**2,191**		**249**		

FINANCIAL STATEMENT.

Lot 8. (10 Lambs.)

DEBIT.

To 10 lambs, 799 lbs. @ 2.4 cts.	$19 18
To feed as follows:	
616 lbs. corn @ $19.00 per ton	5 85
616 lbs. wheat @ $17.83 per ton	5 49
1,209 lbs. hay @ $6.00 per ton	3 63
Total expenditures	$34 15

CREDIT.

By 10 lambs, 1048 lbs. @ $5.00 per cwt.	$52 40
Profit on 1 lamb	$1 83

TABLE I.—*Summary of totals.*

Lot.	No. of lambs.	Grain.	Hay.	Water.	Cost of feed.	Total gain.	Average weekly gain.	Total dry matter.	Average lbs dry matter to 1 lb. gain.
1 ----	10	1,196	1,087	1,228	$14.27	205	1.57	1,978	9.65
2 ----	10	1,164	1,173	2,073.5	14.24	230	1.77	2,019	8.77
3 ----	10	1,208	1,142	1,945.5	14.90	233	1.80	1,894	8.12
4 ----	10	1,201	1,199	2,294	14.30	217	1.67	2,076	9.56
5 ----	10	1,266	1,336	1,848.5	15.66	161	1.24	2,249	13.97
6 ----	10	5,685	1,181	364.5	10.65	116	.89	1,759	15.16
7 ----	10	1,460	924	2,547.5	15.48	206	1.58	2,089	10.04
8 ----	10	1,232	1,209	2,191	14.97	249	1.91	2,113	8.48

TABLE II.—*Summary of totals.*

Lot.	Distinguishing rations.	Weekly gain.	Cost of 1 pound gain.	Pounds grain to 1 pound gain.	Digestible. Protein fed per day per 1,000 pounds.	Digestible, Carbohydrates fed per day per 1,000 pounds.	Digestible. Fat.
1	Corn and wheat------------	1.57	$0.069	5.83	1.9	13.1	.584
2	Corn and wheat------------	1.76	.061	5.06	1.9	13.1	.584
3	Corn ----------------------	1.80	.063	5.18	1.8	13.12	.783
4	Wheat --------------------	1.67	.065	5.53	2.07	13.17	.317
5	Corn and wheat------------	1.24	.097	7.86	2.28	15.23	.669
6	Sugar Beets----------------	.89	.091	49.00	1.71	11.57	.303
7	Corn, wheat, oats and bran-	1.58	.075	7.08	2.27	12.76	1.014
8	Corn and wheat------------	1.91	.06	4.91	2.13	14.33	.64

TABLE III.—*Weekly gains.*

Date.	Lot 1.	Lot 2.	Lot 3.	Lot 4.	Lot 5.	Lot 6.	Lot 7.	Lot 8.	Average weekly gain.
Dec. 2----------------	------	2.1	2.5	1.6	-.6	-.6	3.7	1.3	1.7
" 9----------------	2.3	1.8	1.6	1.7	-4.0	-.6	.2	2.0	1.1
" 16----------------	2.5	2.6	2.8	2.9	4.9	1.0	1.0	1.6	2.4
" 23----------------	-.3	1.4	2.7	-.3	4.8	.9	.4	2.5	1.8
" 30----------------	2.6	1.7	.4	1.9	-.6	.7	2.7	1.7	1.3
Jan. 6----------------	1.8	1.7	1.7	2.0	3.4	1.2	1.8	2.8	2.1
" 13----------------	2.9	.6	1.6	2.4	1.4	1.2	1.2	2.0	1.7
" 20----------------	1.5	2.6	2.3	.8	3.2	1.7	2.9	2.2	2.2
" 27----------------	2.2	1.7	2.0	2.7	-1.6	1.5	.3	1.7	1.3
Feb. 3----------------	2.3	2.1	1.6	3.8	4.6	.6	2.8	3.9	2.7
" 10----------------	.9	-.8	.9	.1	-2.4	2.6	-1.2	-1.3	-1.2
" 17----------------	1.5	3.0	3.4	2.1	4.4	.8	5.0	3.3	2.9
" 24----------------	.3	2.4	-.2	0.0	-1.4	.6	-.2	1.2	.2
Total --------- ----	20.5	23.0	23.3	21.7	16.1	11.6	20.6	24.9	------

EXPOSURE VS. CLOSE CONFINEMENT.

It is a universally accepted principle among physiologists that too much exposure or an undue amount of exercise is not favorable for the profitable production of fat.

Experiments with domestic animals, bearing on this subject, have quite uniformly supported this belief. Among those engaged in fattening animals for the shambles, there is some diversity of opinion, many believing that a reasonable amount of exercise is not to be regarded as unfavorable to profitable food consumption. Such feeders have therefore allowed their fattening animals more or less freedom, and have never insisted on close confinement as an important or even desirable condition for this class of animals. Others, among whom may be mentioned many of the most prominent English feeders, have gone to the other extreme and have successfully practiced stall feeding. Most of the experiments recorded have been with cattle and very few definite experiments seem to have been conducted with a view to testing the effect of the same conditions on fattening sheep.

Sheep are much better protected by the natural covering of their bodies than cattle, and it is possible that the same amount of exposure and confinement might not affect them to the same extent. A large number of experiments conducted at this station with fattening sheep seem to indicate that they may be kept too warm, and it is possible that we may have insisted too strongly on the harmful effects of exposure. One of the experiments in the series here recorded was undertaken for the purpose of investigating the effect of exposure on fattening sheep. Twenty lambs were divided into two equal lots numbered respectively one and two. Both lots were fed a grain ration composed of equal parts by weight of corn and wheat, and a fodder ration of clover hay.

Lot 1 was allowed the run of a yard ten rods in length by five in width, which was immediately adjacent to the east end of the experimental sheep barn, and were fed in the pen opening into this yard. They were at no time shut in the barn, even during the severest weather, and, as not infrequently happened, were often drenched with rain or covered with snow. Lot 2 received exactly the same ration as lot 1, but differed somewhat in the total amount of food consumed during the period. They were placed in an adjoining pen, and at no time were allowed to go outside of the barn.

The results are tabulated below:

TABLE IV.

Distinguishing difference.	Lot.	Grain.	Hay.	Water.	Cost.	Gain.	Average weekly gain.	Total dry matter.	Dry matter to 1 pound gain.
Out door	1	1,197	1,087	1,228	$14 27	205	1.57	1,978	9.65
In door	2	1,164	1,173	2,073	14 24	230	1.77	2,019	8.77

The results are not very definite and certainly not conclusive, based as they are upon a single experiment. The outdoor lot consumed some more grain, less hay and drank less water than the lot kept constantly confined.

The cost of the rations was practically the same. The increase in live weight was considerably in favor of the lot fed inside. The crucial test of all comparative experiments of this kind, viz.: the amount of dry matter required to produce a pound of gain, is considerably in favor of the lot fed inside. The profit resulting from the lot properly sheltered was considerably greater than from the lambs that were allowed the freedom of the large yard, and amounted to twelve cents per head.

If this experiment furnishes any evidence on this subject it is against outdoor feeding, and indicates that protection from exposure is a factor in the profitable fattening of sheep.

WHEAT FOR FATTENING LAMBS.

Previous to this set of experiments we have never fed wheat to fattening lambs as the sole grain ration. Its value in a mixed grain ration has been tested and proven very satisfactory, both as to gains made and resulting profit. This experiment was conducted for the purpose of determining the relative value of an exclusive grain ration of wheat as compared with others of our more common grains.

Lot 4 was employed for this purpose and received wheat as the sole grain ration, supplemented by clover hay. They were fed all they would eat up clean of these two foods, and, as will be seen by the table below, consumed 1,201 pounds of wheat, 1,199 pounds of hay, and drank 2,294 pounds of water. The total gain was 217 pounds or 1.67 pounds per lamb and week as is shown in table 5. These results are compared with lot 3, which received corn as an exclusive grain ration, but in all other respects was treated like the wheat fed lot (4).

TABLE V.—*Wheat for fattening lambs.*

Distinguishing ration.	Lot.	Grain ration.	Hay.	Water.	Cost of feed.	Total gain.	Average weekly gain.	Total dry matter.	Dry matter to 1 pound gain.
Corn	3	1,208	1,142	1,945	$14 90	233	1.80	1,894	8.07
Wheat	4	1,201	1,199	2,294	14 30	217	1.67	2,076	9.56

It will be observed from the above table that while the wheat fed lot made somewhat smaller gains and required more dry matter to produce one pound of gain, the increase in live weight was on the whole rather above the average. Our experience for two seasons with feeding wheat would lead us to the conclusion that the dry matter in wheat is less valuable for fattening lambs than the dry matter in corn. Still, if the prices for wheat prevailing during this experiment are again experienced, it will be more profitable to feed the wheat on the farm than to sell in the open market.

SHEARING LAMBS IN THE FALL.

Several experiments have indicated that shearing late in the winter, toward the close of the feeding period, is usually attended with good results. A few experiments have seemed to indicate that shearing before the fattening period begins is a profitable practice, while others have shown no advantage from fall shearing.

To test this question, lot five was shorn during the week ending December third. In the investigation of this subject our observations were confined to three points: effect on gain, the amount of dry matter required to produce one pound of gain, and the ultimate profit.

The shorn lambs were fed in the same barn with the other lots under experiment, but were further protected by a board partition extending to the ceiling, entirely enclosing the feeding pen. This pen was supplied with a window opening to the outside air like the other lots, but unlike the others this window was kept closed throughout the experiment. Notwithstanding all these precautions for protecting them against the rigors of winter, they suffered more or less from the cold. There is little question but that had it been possible to give them still warmer quarters the results here recorded would have been less disparaging to the shorn lot. Lots two and five were compared; the former was fed a grain ration of corn and wheat and a coarse fodder ration of clover hay; the latter was fed and handled in exactly the same manner except that the lambs were shorn and were confined in somewhat warmer quarters as described above.

The results are tabulated below:

TABLE VI.

Distinguishing difference.	Lot.	Grain.	Hay.	Water.	Cost of feed.	Total gain.	Average weekly gain.	Dry matter to 1 pound gain.
Unshorn	2	1,164	1,173	2,073	$14 24	230	1.7[illegible]	8.77
Shorn	5	1,166	1,336	1,848	15 66	161	1.24	13.97

The shorn lambs made smaller gains, ate more food and consequently required more dry matter to produce one pound of gain than did the lambs fed in an exactly similar manner but not shorn. An examination of the financial statements in connection with lots two and five will reveal the fact that in this experiment, at least, there was no advantage, but rather a disadvantage, from fall shearing.

No one experiment can furnish sufficient data for definite and sweeping conclusions, and the above results are tentative and may or may not be borne out by later experiments.

ECONOMY OF A SELF FEED.

A self feed is an arrangement by which animals may supply themselves with grain at all times. The usual method of feeding is to fill the grain racks once in three or four days or perhaps only once each week. The practice differs somewhat in different localities, some feeders supply the grain to the fattening animals as described above, while others clean the feeding troughs daily, furnishing no more food than will satisfy the animals until the next feeding time. The two practices are essentially the same in character and results. This method of fattening is popular, especially with those feeding a large number of animals, requiring the attention of several feeders; but we have found it in common use among

those who fatten but a small number annually. An investigation of this practice draws attention to two points: 1. Effect on the gain in live weight. 2. The relative amount of dry matter required to produce the gains made.

Below will be found a table which includes the data collected in our investigation of this point in the season, 1894-5.

TABLE VII.—*Economy of a self feed.*

Distinguishing rations.	Lots.	Grain.	Hay.	Water.	Cost of feed.	Gain.	Average weekly gain.	Dry matter to 1 pound gain.
Ordinary	2	1,164	1,173	2,073	$14 24	230	1.77	8.77
Self feed	7	1,460	924	2,547	15 47	206	1.58	10.04

In the above table, lot two was fed twice each day, as described in previous pages of this bulletin. The ration of lot two was composed of equal parts by weight of corn and wheat mixed, and clover hay. Lot seven was fed by means of four self feeders, one containing corn, another barn, another wheat, and still another oats. These self-feeders were kept filled with the grain, but were so constructed that the food worked its way down to the feeding trough no faster than the animals ate it from below. In previous experiments we have mixed the grain for the animals and supplied it to them through one rack, but we believe the arrangement described above is preferable. An examination of the weekly records of lot seven, page 56, will exhibit some interesting figures, tending to show the apparent preference of the animals for certain grains over others.

The lambs ate five hundred and fifty-six pounds of corn, four hundred and sixty-seven pounds of bran, two hundred and forty-seven pounds of oats and one hundred and eighty-nine pounds of wheat. This is seemingly a very favorable showing for corn, as the main food in the fattening ration. Referring again to table seven, it will be observed that the self fed lambs ate considerably more grain, a little less hay, drank more water, and made a smaller total gain than lot two, fed in the ordinary way. The point of greatest significance, however, is the amount of dry matter required to produce a pound of increase in live weight, and this is manifestly greatly in favor of lot two, receiving its food regularly and at stated times. Lot seven fed by means of a self feed required 10.04 pounds of dry matter to produce one pound of gain, while lot two required but 8.77 pounds. In this experiment the results are clearly against the use of the self feed. The total gains made and the amount of food required to produce a given increase in weight all seem to be distinctly favorable to the practice of regular and systematic feeding conducted with judgment on the part of the attendant.

TABLE VIII.—*Three years feeding with a self feed.*

Year.	Grain.	Hay.	Roots.	Total gain.	Average weekly gain.	Dry matter to 1 pound gain.
1892-3	2,120	528	1,360	260	2.17	9.5
1893-4	1,503	713	....	212	1.77	9.57
1894-5	1,341	854	....	208	1.73	9.66
Average	1,654.6	698.3	....	226.6	1.89	9.57

TABLE IX.—*Three years feeding corn—not self feed.*

Year.	Grain.	Hay.	Total gain.	Average weekly gain.	Dry matter to 1 pound gain.
1892-3	1,123	1,225	300	2.5	6.76
1893-4	1,253	914	286	2.38	6.58
1894-5	1,132	1,056	237	1.97	7.57
Average	1,169.3	1,065	274.3	2.28	6.97

Tables VIII and IX contain the average results of three years' experiments with a self feed as compared with a similar number of experiments with lambs fed corn and clover hay and supplied in the ordinary manner. The results are reduced to the uniform period of twelve weeks. In every instance the lambs fed at regular intervals (table IX) made the greatest gains and produced those gains at least expense of dry matter. The experiments are quite conclusive, extending as they do over a period of three years under varying conditions and with different lots of sheep. We are led to the conlusion that fattening lambs by means of a self feed is an expensive practice, and that economy of production requires more attention to the variation in the appetites of the animals than can be given by this method.

FEEDING ON RAPE AS A PREPARATION FOR WINTER FATTENING.

Rape has been somewhat extensively used at this station and throughout the State for the fall pasturage of sheep intended for winter fattening. It has rapidly grown in favor since it produces a large amount of forage to the acre, the efficiency of this material for fattening sheep and the ease with which it may be grown. It may be used as a catch crop after oats and peas which have been cut for hay or even after an ordinary hay crop. As a rule, lambs may be pastured on rape from September fifteenth to November fifteenth at the rate of fifteen or twenty lambs per acre, and they should gain in this time twenty pounds each.

The experiments with rape at this station have indicated that rape-fed lambs were in much better condition at the beginning of winter than those pastured on grass. This fact has led us to consider whether more profitable gains might not be made by lambs in poorer condition at the beginning of the fattening period. To test this matter an average lot of lambs were selected from the flock and placed upon a second growth timothy and June grass meadow, for comparison with the main flock which had been turned on the rape. The rape-fed lambs gained much more rapidly from the first than those upon the meadow and at the time of placing in the barns for the winter's experiments, ten of the rape-fed lambs weighed 851 pounds, while the same number of pasture-fed lambs weighed only 799 pounds. The following table illustrates the main points of difference between the two lots from the beginning of the winter period of fattening to its close:

TABLE X.

Distinguishing difference.	Lot.	Grain ration, corn and wheat, lbs.	Fodder ration, hay, lbs.	Water, lbs.	Cost of feed.	Gain, lbs.	Weekly gain, lbs.	Dry matter to 1 pound gain, lbs.
Rape-fed	2	1,164	1,173	2,073	$14 24	230	1.77	8.77
Grass-fed	8	1,232	1,209	2,191	14 97	249	1.91	8.48

The grass-fed lambs (lot eight) ate rather more grain and hay, drank more water, made somewhat larger gains and required a larger amount of dry matter for each pound of gain than the rape-fed (lot two) lambs. A comparison of the financial statements for these lots will reveal the fact that the lot fed on rape were more profitable under the conditions existing in these experiments; but the financial results are not justly comparable from the fact that the live weight of lot two was considerably greater than lot eight at the beginning of the experiment.

Had the lots at that time been of equal weight not only the gains and amount of dry matter required to produce a pound of gain, but the financial results would have shown a slight advantage in favor of the grass-fed lambs. The difference, however, is very slight, and we must conclude from this experiment that rape-fed lambs are not to be considered undesirable for winter fattening.

The following letter from the commission men who sold in Buffalo, N. Y., the lambs fed during the winter of 1894–5, indicates the quality of the animals. It also illustrates the fact that even when selling lambs to the butcher it pays to take pains to have the general appearance as attractive as possible.

East Buffalo, N. Y., March 14, 1895.

MR. F. B. MUMFORD, *Agricultural College, Mich.:*

DEAR SIR—We are in receipt of your favor of the 13th and note contents. In reply would say that the bunch of lambs you refer to numbering 69 head and which weighed here 98 lbs. we sold at $6.10, which is the highest price for any load of lambs sold so far this year. Of course there have been several small bunches of 10 to 30 prime lambs which have sold $6.15 to $6.30 but for a large bunch your lambs were the highest sold of any up to the present writing.

We liked the lambs very much and called them as near perfect as could be. The skins, quality, and weight were just what we wanted and they will command a premium over the general run of lambs any time. Cotswold Canadian lambs sell for a little more money inasmuch as the skins are worth a little more to the slaughterers, but we do not believe Cotswold lambs kill any better than the grade you had here.

We might have sold your lambs for a little more money had they been trimmed about the tail such as stock that goes to county fairs, etc., and they would have made a little better showing and possibly have brought a little more money. The lambs otherwise were prime, well finished and in fact, the best set of lambs we have seen here this season.

The shorn lambs which sold $1.00 per hundred under the prices of wool lambs were here too early in the season and were not wanted.

Any information we can give you any time we shall be pleased to do so, and we thank you very kindly for the offer you have made us to send us the results obtained by the feeding of these lambs, etc.

Respectfully yours,

(Dictated.) ERICK BROS.

SUMMARY AND PRACTICAL CONCLUSIONS.

1. Sheep are more economically fattened when more or less closely confined than when subjected to an undue amount of exposure or too much exercise.

2. Wheat compares favorably with corn, as the main or exclusive grain in a ration, and is a profitable grain to feed under conditions like those existing during this experiment.

3. In this experiment shearing at the beginning of the fattening period was not followed by good results, either from the point of economy of production or the amount of dry matter required to produce a pound of gain.

4. Feeding by means of a self feed is an expensive method of fattening and is not to be recommended either from the standpoint of total gains made or the amount of dry matter required to produce a given gain.

5. The animals in this experiment fattened on rape during the fall and in good condition at the beginning of the experiment were essentially as successful feeders as those in poorer condition that where fed during the fall on ordinary grass pasture.

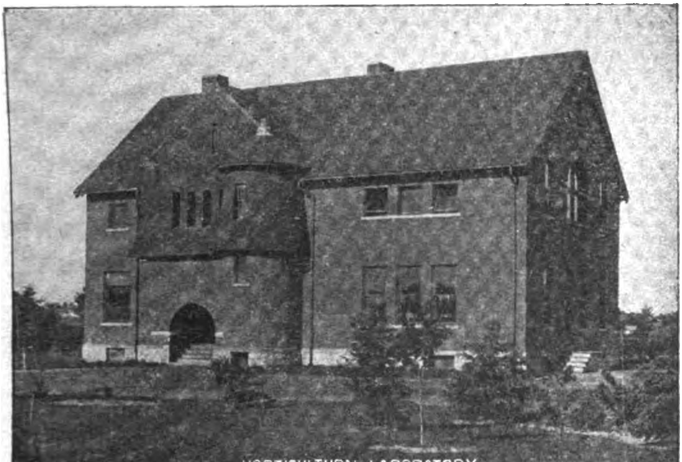
BULLETINS 129, 130 FEBRUARY, 1896

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

HORTICULTURAL DEPARTMENT



HORTICULTURAL LABORATORY

129 Fruits at South Haven

130 Fruits at the Agricultural College

AGRICULTURAL COLLEGE, MICHIGAN
1896

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No. 65. Planting for Honey.

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69. Feeding Steers of Different Breeds.

77. Comparing the Yield of Old Meadows with those Recently Planted.

78. Glanders and Farcy.

79. Vegetable Tests.

98. Locusts and the Horn Fly.

103. Peach and Plum Culture.

105. Michigan Fruit List.

113–16. (In one volume.) Fattening Lambs. Rape as a Forage Plant. Management of Swamp Lands. Insects in the Clover Field.

117. Millet.

118. Fruits at South Haven.

119–20. Potatoes. Vegetable Novelties and Notions.

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125. Crimson Clover and Other Topics.

126. Fertilizer Analyses.

127–28. Dairy Records. Fattening Lambs.

I. H. BUTTERFIELD,
Secretary.

BULLETINS 129-130 FEBRUARY, 1896

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

HORTICULTURAL DEPARTMENT.

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129 Fruits at South Haven

130 Fruits at the Agricultural College

AGRICULTURAL COLLEGE, MICH.
1896

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A. A. CROZIER, M. S.,	Assistant in Agriculture.
HERBERT W. MUMFORD, B. S.,	" " "
H. P. GLADDEN, B. S.,	Assistant in Horticulture.
M. L. DEAN,	" " "
THORN SMITH, B. S.,	Assistant in Chemistry.
E. A. A. GRANGE, V. S.,	Consulting Veterinarian.
G. C. DAVIS, M. S.,	Consulting Entomologist.
CHAS. F. WHEELER, B. S.,	" Botanist.
Mrs. L. E. LANDON,	Librarian.
T. T. LYON, So. Haven,	In charge of Sub-Station.
R. L. TAYLOR, Lapeer,	In charge of Apiary.

SUB-STATIONS.

Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.

FRUITS AT SOUTH HAVEN.

BY T. T. LYON.

To Prof. L. R. Taft, Horticulturist:

SIR—In submitting this, my annual report of operations at the South Haven sub-experiment station, during the year 1895, I take occasion to state that this and the previous season have proved exceptional, from the prevalence of a severe drouth during the summer of 1894, followed by inadequate rainfall during the autumn; while that of the spring of 1895 was also comparatively slight. With the advent of growing weather, on May 6 and 7 copious showers occurred, with more or less rain during the next ten days. From that date forward only very rare sprinkles or slight showers occurred prior to September 11, while even this and subsequent rainfalls have been scarcely adequate to the needs of vegetable growth.

Under such conditions resort has been had to the frequent stirring of the soil by the free use of the cultivator. This has proved effective for the maintaining of a very satisfactory growth upon trees and deep rooting plants generally, excepting those recently planted, and such others as were carrying heavy crops of fruit. In such cases, resort was had to watering, which was done by opening a trench about the tree, to receive the water, and replacing the earth after the absorption of the water. This proved to be a tedious and expensive process, since it was necessary to haul the water from Lake Michigan, the village water works not being within reach and the capacity inadequate.

While yet dormant the entire plantation was sprayed with a solution of two pounds of copper sulphate in 50 gallons of water. On account of the early starting of gooseberries and currants, they were sprayed on March 18. On April 1 to 10 the same was applied to raspberries, blackberries, strawberries, grapes and tree fruits generally.

Subsequent sprayings will be noticed in connection with the several species of fruits.

As far as practicable the "Rules of Pomology" of the American Pomological Society, and the National Division of Pomology, are applied in the correction and simplifying of the names of fruits. Under these rules,

in cases in which the suppression of a redundant or objectionable word, or part of a word, in the name of a fruit would, by possibility, occasion ambiguity, such word, or part of a word, is temporarily retained, in brackets, with the purpose to wholly omit the same when (if ever) the suggested change shall come to be generally recognized.

Throughout this report, the *weight* of a single average specimen of a variety of fruit is given, instead of its *size*; the same being assumed to be the more accurate indication of its value and, at the same time more readily arrived at; the thought being that such weight, rather than size, may ultimately be employed as the medium for the comparison of values between varieties.

The several classes of fruits will be considered, as nearly as practicable in the order of their maturity.

STRAWBERRIES (*Fragaria*).

The strawberry plat which produced its first crop of fruit in June, 1894, was kept in good condition, and again fruited in 1895. A record of such second crop was kept, as usual, and compared with that of a plat producing its first crop at the same time; the product of the same variety, in each plat, appearing in parallel columns. The two plats received the same treatment, as nearly a practicable, there being of each variety twelve plants, in hills and a matted row, grown from twelve original plants, in the older plat, against ten plants of each respectively in the newer plat. It will also be noticed that many vacancies occurred in the record of the older plat, for the reason that many newer varieties, which appear in the newer plat, had not occurred in the older one; while a few varieties in the older plat, were so seriously injured by drouth or winter that their record is omitted.

Both plats were sprayed on July 8th, after they were out of fruit, with a solution of three ounces of copper sulphate in fifty gallons of water. The plants generally have been almost wholly free from the depredations of either insects or fungi.

The vigor and fruiting capacity of the plants, in both plats, was doubtless injuriously affected by the drouth of last season, the older plat probably the most seriously. Following this came the drouth of the past spring and summer, which became serious at so early a date as to essentially affect both the quantity and quality of the current crop of fruit. As a necessary consequence, several varieties, especially in the older plat, showed more or less deficiency in the stand of plants, as well as in the show of fruit. For such reason, several varieties contained in the older plat are omitted in the tabulation.

The weight of a specimen in ounces or fractions of an ounce, is given instead of size, as more accurately expressing actual value, while vigor of plant is expressed upon the scale of 1 to 10, graded from one downward.

TABULATION OF STRAWBERRIES FROM ONE AND TWO YEAR PLATS.

Number.	Names.	Sex. b—bisexual. n—nearly. p—pistillate.	When received.	Earliest bloom.	First picking.	Last picking.	Ounces. 1st year. Hills.	Ounces. 1st year. Matted row.	Ounces. 2d year. Hills.	Ounces. 2d year. Matted row.	Vigor of plant, 1-10.	Weight of berry in ounces.
1	Accomac	b	1893	May 2	June 10.	June 29.	9½	9	-----	-----	8	¼
2	Afton	p	1892	May 2	June 7.	June 29.	20½	21½	6	22	5	1
3	Allen 5	p	1894	May 6	June 3.	June 17.	8½	12	-----	-----	6	1
4	Allen 6	p	1894	May 4	June 5.	June 21.	13	14½	-----	-----	1	1
5	Allen 13	p	1894	May 1	June 1.	June 17.	16½	14½	-----	-----	3	½
6	Aroma	b	1894	May 6	June 10.	June 26.	14½	6½	-----	-----	5	½
7	Auburn	p	1892	May 6	June 3.	June 19.	6½	8½	-----	-----	6	1
8	Augwick	p	1892	May 3	June 3.	June 24.	5½	16½	7	14	7	1-5
9	Australian (Crim.)	b	1891	April 30.	June 3.	June 8.	1	8	-----	-----	3	½
10	Australian (Everbear.)	b	1890	May 2	June 3.	June 21.	18	12½	-----	-----	5	½
11	Banquet	p	1893	April 29.	June 3.	June 21.	20	37	24½	43½	8	½
12	Barton	p	1891	May 2	June 1.	June 26	20	39	20½	18½	6	½
13	Beauty	b	1892	April 30.	June 1.	June 24.	34½	41½	8	38	7	½
14	Beebe	b	1894	May 2	June 5.	June 24.	18½	17	-----	-----	3	½
15	Beecher	b	1894	May 9	June 12.	June 24.	18	20	-----	-----	2	½
16	Belt 2	b	1892	May 4	June 5.	June 26	10½	29	39½	32	8	⅓
17	Beverly	b	1893	May 3	June 5.	June 26.	14½	7½	5	15	5	½
18	Bickle	p	1894	May 1	June 5.	June 24.	25	20	-----	-----	2	½
19	Boynton	p	1891	April 29.	June 1.	June 14.	29	28½	48½	46½	2	½
20	Brandywine	b	1893	April 29.	June 1.	June 24.	8½	12½	-----	-----	3	½
21	Brunette	b	1893	May 2	June 1.	June 17.	11	19	-----	-----	2	½
22	Bubach 5	p	1888	May 4	June 1.	June 26.	22	28½	14½	34½	2	½
23	Californian	b	1891	May 2	June 10.	June 26.	3½	13	-----	-----	2	¼
24	Cameron 2	b	1894	April 29.	June 1.	June 24.	18½	8½	-----	-----	4	½
25	Cameron 6	n p	1894	May 3	June 10.	June 24.	5	8	-----	-----	1	½
26	Cameron 13	p	1894	May 6	June 10.	June 30.	24	22	-----	-----	2	½
27	Cameronian	p	1893	May 3	June 7.	June 26.	10½	13½	-----	-----	6	¼
28	Chairs	p	1893	May 2	June 7.	June 26.	31½	15½	23½	20½	5	⅓
29	Charlie	p	1894	May 4	June 6.	June 26.	45½	30	-----	-----	2	½
30	Cheyenne	p	1894	May 8	June 7.	June 30.	22	15	-----	-----	4	1
31	Clark	b	1893	May 2	June 1.	June 26.	6½	16½	-----	-----	6	½
32	Cleveland	p	1888	May 2	June 3.	June 19.	11	8½	36½	25½	6	½
33	Columbia	b	1894	May 2	June 5.	June 26.	8	17	-----	-----	4	¼
34	Conesengus	p	1893	May 3	June 10.	June 26.	12½	11	-----	-----	5	½
35	Copernicus	p	1893	May 3	June 10.	June 26.	11	16	21	40	5	½
36	Crescent	p	1888	May 3	June 1.	June 21.	13½	18½	72½	56½	7	½
37	Cruse	b	1894	May 4	June 7.	June 24.	12½	22½	-----	-----	---	½
38	Curtis 15	b	1893	May 2	June 1.	June 26.	24½	15	27½	51	8	½
39	Curtis 159	p	1893	May 2	June 1.	June 26.	37	24½	39½	63	9	1
40	Cyclone	b	1894	April 29.	June 1.	June 24.	20	15	-----	-----	6	1-6
41	Daisy	p	1890	April 29.	June 1.	June 17.	8½	25	55½	79	6	¼
42	Dan Bisel	b	1894	May 4	June 3.	June 29.	42	28½	-----	-----	2	1-5
43	Dayton	b	1893	May 2	June 1.	June 21.	18	16	41½	43½	5	½
44	Early Jack	b	1894	May 1	June 1.	June 19.	48½	74	-----	-----	1	1
45	Edgar	p	1890	May 4	June 10.	June 17.	2½	3½	32	56	5	½
46	Edward (Fav.)	b	1894	May 8	June 12.	June 29.	6½	17½	-----	-----	---	½
47	Edith	p	1894	May 9	June 17.	June 26.	5	15	-----	-----	5	½
48	Edwards	b	1894	May 7	June 12	June 29.	6½	17½	27½	46½	4	½
49	Enhance	b	1890	May 2	June 10.	June 29.	23	20	21	53½	4	½
50	Epping	p	1894	May 4	June 7.	June 26.	22½	14½	-----	-----	4	½
51	Equinox	b	1894	May 2	June 17.	June 27.	3½	11½	-----	-----	---	½
52	Estelle	b	1891	May 6	June 14.	June 26.	5½	3¼	24½	14	---	½
53	Eureka	p	1888	May 6	June 10.	June 24.	15	16½	17½	29½	---	½
54	Fairmount	b	1891	May 1	June 3.	June 26.	22	38½	52½	60½	5	⅓
55	Feicht 2	b	1894	May 4	June 3.	June 21.	12½	16½	-----	-----	4	½

STRAWBERRIES.—CONTINUED.

Number.	Names.	Sex. b—bisexual. n—nearly. p—pistillate.	When received.	Earliest bloom.	First picking.	Last picking.	Ounces. 1st year. Hills.	Ounces. 1st year. Matted row.	Ounces. 2d year. Hills.	Ounces. 2d year. Matted row.	Vigor of plant, 1-10.	Weight of berry in ounces.
56	Feicht 3	p	1894	May 4	June 5	June 29	19½	23	------	------	5	½
57	Fir	b	1894	May 2	June 3	June 24	15½	7	------	------	6	⅓
58	Florence	b	1888	May 3	June 1	June 26	17	21	44½	75	4	½
59	Gipsy	p	1894	May 2	June 3	June 21	35½	40	------	------	3	½
60	Glenfield	b	1894	May 3	June 3	June 24	17	11½	------	------	2	¼
61	Greenville	p	1891	May 4	June 3	June 26	43	50½	66	61	10	½
62	Harmon	b	1894	April 29	June 1	June 19	14½	11	------	------	2	½
63	Hattie	p	1892	May 4	June 5	June 26	51½	36	72	67	9	⅓
64	Haverland	p	1887	April 29	June 1	June 26	41½	31½	40	42	4	½
65	Hermit	b	1893	April 29	June 3	June 24	10½	19½	45	90	6	1-5
66	Hinman	b	1890	May 3	June 7	June 24	21½	14½	36	61½	4	½
67	Hoard	b	1888	May 2	June 5	June 21	14	16	21	21½	2	½
68	Holyoke	b	1891	May 2	June 7	June 26	24	32½	35½	60	2	½
69	Hugo	b	1891	May 2	June 5	June 29	8	15	------	------	6	½
70	Huntsman	b	1893	May 3	June 5	June 24	18	21½	9	29	1	½
71	Hyslop	b	1892	April 29	June 5	June 19	12	13	12½	38½	2	⅓
72	Iowa	b	1893	April 29	June 7	June 17	4½	4½	------	------	8	⅓
73	J. S. 4	p	1894	May 2	June 5	June 26	31½	37½	------	------	2	⅓
74	J. S. 6	p	1894	May 3	June 5	June 26	25	11	------	------	1	½
75	Kansas	b	1894	May 2	June 3	June 24	36	50	------	------	1	½
76	Katie	b	1893	May 3	June 3	June 21	11½	11	27	38	3	1
77	Klickita	p	1894	May 4	June 12	June 24	8½	7	------	------	1	1-6
78	Kossuth	b	1894	April 30	June 1	June 24	18	15	------	------	3	½
79	Lacrosse	n p	1893	May 6	June 10	June 26	3	10	19	45	1	¼
80	Leader	b	1892	April 29	June 1	June 21	28	35	------	------	3	1
81	Lehigh	p	1891	April 29	June 1	June 19	37½	9½	61½	114½	2	1-5
82	Leroy	p	1892	April 29	June 1	June 26	13	11½	22	22½	2	⅓
83	Leviathan	b	1892	May 6	June 1	June 26	24½	23½	15	21	2	½
84	Lincoln	p	1892	April 29	June 3	June 29	66	4½	83	128½	1	½
85	Little 26	b	1894	May 4	June 12	June 24	9½	5	------	------	1	------
86	Little 42	n p	1894	May 3	June 5	June 24	21	11	------	------	1	½
87	Longfield	p	1894	May 2	June 1	June 24	37	17½	------	------	2	¼
88	Lovett	b	1891	April 30	June 1	June 24	42	19	29½	41½	1	½
89	Lower	b	1894	May 3	June 12	June 19	3½	3	------	------	3	1-5
90	Magnate	p	1894	May 1	June 1	June 19	14½	14½	------	------	2	⅓
91	Marshall	b	1891	May 6	June 11	June 19	2	2	------	------	------	------
92	Mary	p	1894	May 6	June 11	June 24	14½	5	------	------	1	⅓
93	Maxwell	b	1894	April 30	June 1	June 21	20½	10	------	------	1	1
94	Meeks	b	1894	May 1	June 3	June 21	5½	13	------	------	1	½
95	Miami	p	1889	May 4	June 5	June 21	11	15½	35	66	3	½
96	Miller	b	1890	May 8	June 12	June 24	14½	8	------	------	1	1-6
97	Monroe	b	1891	May 3	June 7	June 24	15½	17½	------	------	5	¼
98	Muskingum	b	1893	May 6	June 12	June 29	59½	26	31½	75½	2	⅓
99	Mystic	b	1892	May 6	June 14	June 29	6	12½	15½	11½	5	⅓
100	Neptune	p	1890	May 6	June 13	June 26	5	8½	31½	46½	5	½
101	No Name	n p	1894	May 7	June 3	June 26	26	22½	------	------	4	⅓
102	No. 31	b	1894	May 8	June 12	June 26	5½	3	30½	44	1	¼
103	Odessa	p	1894	May 4	June 10	June 26	6½	9	------	------	1	1-5
104	Ohio Centennial	b	1893	May 6	June 10	June 29	8½	24	37½	42	5	½
105	Ona	p	1894	May 2	June 3	June 24	17	11	------	------	4	¼
106	Oregon	p	1891	May 1	June 5	June 26	9½	10	------	------	5	⅓
107	Oregon 278	b	1894	May 4	June 7	June 24	8	6½	------	------	3	½
108	Oscar	b	1894	May 6	June 10	June 21	4	2½	------	------	7	1-5
109	Ostego	p	1894	May 4	June 5	June 26	25½	31	------	------	2	½
110	Pacific	p	1890	May 1	June 5	June 26	47	23	36	61	1	½

STRAWBERRIES.—CONTINUED.

Number.	Names.	Sex. (b—bisexual. n—nearly. p—pistillate.)	When received.	Earliest bloom.	First picking.	Last picking.	Ounces. 1st year. Hills.	Ounces. 1st year. Matted row.	Ounces. 2d year. Hills.	Ounces. 2d year. Matted row.	Vigor of plant, 1-10.	Weight of berry in ounces.
111	Parker Earle	b	1889	May 2	June 5	June 24	22½	18½	31½	31½	2	½
112	Pawnee	p	1894	May 8	June 7	June 29	32	29½	-----	-----	2	½
113	Phillip	b	1894	May 4	June 3	June 26	12½	3	-----	-----	1	½
114	Price	b	1894	May 1	June 1	June 29	31	20½	29½	36	1	½
115	Primate	b	1894	May 7	June 12	June 24	22	13	-----	-----	3	½
116	Princess	p	1893	May 3	June 3	June 29	27½	23	60	79½	3	½
117	Princeton	b	1894	April 30	June 7	June 26	31½	17½	-----	-----	2	½
118	Puritan	n p	1887	April 29	June 1	June 14	18½	27½	32½	57½	5	½
119	Putnam	p	1890	May 7	June 12	June 29	10	4½	48	57½	1	½
120	Regina	p	1890	May 4	June 14	June 29	12½	15	-----	-----	3	1-5
121	Richmond	b	1894	May 6	June 5	June 26	33	27½	-----	-----	1	½
122	Ri·hl 6	b	1893	May 6	June 5	June 26	24	18½	20½	25½	3	½
123	Rio	b	1890	May 1	June 3	June 17	14½	24½	-----	-----	3	½
124	Robinson	b	1894	May 1	June 7	June 24	17½	11	-----	-----	1	½
125	Sadie	p	1890	April 30	June 1	June 24	35	50½	47½	103½	3	½
126	Sandoval	b	1890	May 2	June 5	June 24	15½	15½	24½	42	4	⅛
127	Saunders	b	1889	May 8	June 5	June 26	23	33½	115½	126	3	½
128	Scarlet Ball	p	1893	May 6	June 14	June 24	14	6½	59	59½	1	½
129	Shawnee	n p	1894	April 29	June 1	June 26	29½	18½	-----	-----	3	½
130	Shuckless	b	1894	May 6	June 12	June 29	8	10	-----	-----	1	⅛
131	Smalley	p	1894	April 30	June 5	June 29	17½	14½	-----	-----	6	½
132	Smeltzer	b	1894	May 2	June 5	June 17	14½	17	-----	-----	8	½
133	Smith	b	1894	April 30	June 1	June 19	26½	31	-----	-----	1	½
134	Stahelin	p	1894	May 2	June 1	June 29	31½	27½	-----	-----	1	½
135	Southard	b	1892	April 29	June 1	June 24	24	15½	42½	58½	5	½
136	Speece	p	1890	May 2	June 3	June 29	33½	25½	54	70½	1	½
137	Splendid	b	1893	May 1	June 1	June 24	30	45	16½	52	1	1
138	Springdale	b	1894	May 3	June 5	June 26	9½	8	-----	-----	6	½
139	Standard	b	1894	May 1	June 1	June 21	8½	8½	-----	-----	2	1-5
140	Surprise	b	1892	May 1	June 1	June 24	14½	10	16	32	4	1-5
141	Swindle	p	1892	May 1	June 1	June 24	32	44	14½	31½	4	½
142	Tennessee	b	1894	May 3	June 3	June 26	29	43	-----	-----	3	½
143	Thompson 40	p	1894	May 3	June 3	June 19	42	19½	-----	-----	1	½
144	Thompson 66	p	1894	May 1	June 12	June 26	28	25½	-----	-----	1	1-5
145	Timbrel	p	1893	May 6	June 12	June 29	29	43	16	28½	3	1
146	Tom Walker	p	1894	May 7	June 5	June 24	5½	2½	-----	-----	3	½
147	Tonga	p	1894	May 2	June 5	June 24	28	33	-----	-----	1	½
148	Topeka	b	1894	May 3	June 11	June 21	10½	19½	-----	-----	1	½
149	Van Deman	b	1894	April 30	June 3	June 26	19½	23½	-----	-----	2	½
150	Vick	b	1878	May 4	June 3	June 26	19½	29	-----	-----	3	1
151	Warfield	p	1890	May 2	June 3	June 26	23½	19½	47½	56	1	⅛
152	Weston	p	1893	May 3	June 10	June 26	30½	26	17½	54	2	½
153	Williams	b	1894	May 3	June 7	June 29	26½	21½	40½	77	2	½
154	Wilson	b	1876	April 29	June 1	June 24	16	18	21	57	3	½
155	Wood (Beder)	b	1890	April 29	June 1	June 21	27½	34½	42	97	2	½
156	Woolverton	b	1891	May 9	June 5	June 29	18	47½	49½	109½	1	½

Notices are appended of a few varieties which have shown the highest productiveness during the past unusually unfavorable season; although it may reasonably be inferred that, owing to such exceptional conditions, and possibly, also, to peculiarities of soil or environment, such results may not properly express the real relative values of the varieties noticed, and their ultimate status as compared with many others under trial along with them.

The varieties are noticed in the order of their productiveness during the past season, and the weights of single berries are of those of such crop, which doubtless may be assumed to be rather below than above the average of ordinary seasons.

Early Jack, bisexual, was received from Kansas and planted in the spring of 1894. So far the plant manifests great vigor and hardiness; in weight of berry it ranks very high, many specimens weighing an ounce each; firmness about six, upon the scale running from one downward to ten; quality four; total product from the twenty plants, 112 ounces.

Lincoln, pistillate, was received from Delaware and planted in 1892. In vigor and hardiness it ranks one; firmness and quality, each five; weight of berry, half an ounce; total yield, 108 ounces. This is apparently distinct from the Lincoln (a very early berry) of some fifteen to twenty years since.

Greenville, pistillate, was received from Ohio in 1891. It possesses superior vigor and hardiness; firmness, two; quality, five; weight of berry, half an ounce; total product, 93 ounces. It is worthy of extensive trial as a market berry.

Kansas, bisexual, was received from the state of that name and planted in 1894. So far it ranks one in vigor and hardiness; in firmness, five; in quality, as high as three; weight of berry, half an ounce; total product, 86 ounces.

Hattie, pistillate, was received from J. H. Haynes, Delphi, Ind., in 1892. In vigor and hardiness it ranks two; firmness, four; quality, five; weight of a single berry, one-third of an ounce; total product, 86 ounces. Relatively it has proved more productive this season than usual.

Sadie, pistillate, was received from Ohio in 1890. In vigor it ranks three; in hardiness, two; firmness, four; quality, six; weight of berry, one-third of an ounce; total product, 85 ounces. During this season of excessive drouth this variety appears to have proved relatively more successful than in more favorable seasons.

Haverland, pistillate, was received from New Jersey as early as 1887. It has slowly but steadily won its way to a somewhat prominent position as a market variety, and at the same time, as an excellent variety for the home plantation. In vigor it ranks as low as four; hardiness, two; firmness, three; quality, two; weight of berry, half an ounce; total product, 76 ounces.

Beauty, bisexual, received, in 1892, from Michigan Agricultural College. Vigor, three; hardiness, one; firmness, five; quality, three; weight of berry, half an ounce; total product, 76 ounces.

Swindle, pistillate, was received from G. H. &. J. H. Hale, So. Glastonbury, Conn., in 1892. Vigor, four; hardiness, one; firmness, three; quality, six; weight of berry, one-third of an ounce; total product, 76 ounces. This forbidding name was apparently bestowed with the hope that the variety might be kicked into notoriety as a consequence.

Charlie, pistillate, was received from Virginia in 1894. Vigor and hardiness rank, one; firmness, three; quality, four; weight of berry, one-third of an ounce; total product, 75 ounces.

Gipsy, pistillate, was received from Michigan Agricultural College in 1894. Vigor and hardiness each three; firmness, four; quality, five; weight of berry, half an ounce; total product, 75 ounces. A variety under this name was tested here many years since. The present one is apparently distinct—the plant being more vigorous.

Splendid, bisexual, was received from Illinois in 1893. Vigor and hardiness each one; firmness, three; quality, one; weight of berry, one ounce; total product, 75 ounces.

Mary, Marshall, and several others were planted either in late spring or in summer; for which reason the tabulation does not in such cases properly express their relative character so far as productiveness is concerned.

RASPBERRIES (*Rubus*).

For several years past, the plat of raspberries (including blackberries, which alternate with them), has been in an unsatisfactory condition, such as could only be effectually remedied by replanting in other ground. This was accordingly done last spring, as far as plants were available for the purpose. The remaining vacancies will, in most cases, be filled during the present autumn or next spring, with plants propagated for the purpose upon the premises, except in the case of varieties too rare or recent for the purpose. Of small fruits, ten plants constitute a set.

The foliage of many varieties of raspberries, especially those of *Idæus* and *strigosus* parentage, is frequently attacked by a fungus, which is confined to the lower surface of the leaf, seriously affecting its capacity to aid the growth of the plant and the size and quality of the fruit. This season has not proved an exception; though the attack may have been slightly less severe than usual. A few varieties of *strigosus* parentage, such as Cuthbert, Golden Queen, and perhaps a few others, appear to be, in a measure, exempt from this malady, as in the case with the varieties of *occidentalis*. The spray of copper sulphate, so generally effective against fungi, appears to be ineffective in this case; possibly for the reason that, as usually applied, it rarely reaches the under surface of the foliage, where only this parasite occurs. Another season's experiments are needful to solve this doubt.

Anthracnose continues to manifest itself mainly upon the blackcaps; although, with the free use of the spray of copper sulphate, its depredations have not proved very serious. Most of the suckering varieties have, thus far, escaped the malady in whole or in part.

The only insects which have been at all troublesome this season are the leaf miners, which, apparently, are merely estrays from the adjacent blackberries.

The general spraying given raspberries in common with the entire plantation in March, was repeated upon raspberries on April 27 with one pound of copper sulphate dissolved in 250 gallons of water.

On May 3 raspberries were sprayed for anthracnose, using Bordeaux mixture of the usual strength.

On June 21 repeated the spray for anthracnose, with a solution of one and a half ounces of copper sulphate in fifty gallons of water

In the following tables the weight of a specimen in ounces or fractions of an ounce, is given instead of size, as a more accurate indication of the relative value; while their productiveness is estimated upon the scale, running from 1 to 10; 1 representing the highest degree of productiveness.

RASPBERRIES (*Rubus*).

Number.	Name.	Species.	Received.	Bloomed.	First picking.	Last picking.	Weight of berry in ounces.	Productiveness, scale 1 to 10.
1	American Everbearing	Occidentalis	1893	May 28.	June 29.	July 29.	1-25	2
2	Brandywine	Strigosus	1888	May 31.	July 5.	Aug. 14.	1-16	4
3	Cardinal	Neglectus	1890	May 29.	June 26.	Aug. 5.	1-7	1
4	Carman	Occidentalis	1890	May 24.	June 24.	July 19.	1-17	1
5	Caroline	Neglectus	1888	May 30.	June 28.	July 10.	1-10	1
6	Centennial	Occidentalis	1888	May 23.	June 25.	July 10.	1-13	1
7	Champlain	Strigosus	1895					
8	Church	Strigosus	1894	May 31.	June 28	July 10.	1-14	2
9	Conrath	Occidentalis	1893	May 30.	June 28.	July 10.	1-9	2
10	Cromwell	Occidentalis	1889	May 28.	June 25.	Aug. 7.	1-15	1
11	Cuthbert	Strigosus	1888	May 31.	July 5.	Aug. 7.	1-10	1
12	Doolittle	Occidentalis	1888	May 24.	June 26.	Aug. 7.	1-17	1
13	Earhart	Occidentalis	1888	May 29.	June 24.	Aug. 5.	1-23	1
14	Early King	Strigosus	1894	May 31.	June 28.	Aug. 7.	1-8	2
15	Emmett	Strigosus	1895					
16	Eureka	Occidentalis	1895					
17	Farnsworth	Occidentalis	1891	May 30.	June 26.	Aug. 2.	1-20	1
18	Gladstone	Strigosus	1893	May 30.	June 26.	Aug. 2.	1-16	2
19	Golden Queen	Strigosus	1888	May 31.	June 29.	Aug. 10.	1-12	3
20	Green (New)	Occidentalis	1895					
21	Gregg	Occidentalis	1888	May 31.	July 3.	Aug. 7.	1-13	4
22	Hansell	Strigosus	1888	May 30.	June 20.	Aug. 10.	1-12	2
23	Herstine	Idaeus	1888	May 31.	June 25.	Aug. 5.	1-10	3
24	Hilborn	Occidentalis	1888	May 30.	July 6.	Aug. 5.	1-27	2
25	Idaho	Occidentalis	1890	May 29.	July 1.	Aug. 19.	1-16	4
26	Indiana	Occidentalis	1888	May 30.	June 26.	Aug. 7.	1-12	2
27	Johnston	Occidentalis	1888	May 30.	June 29.	Aug. 7.	1-24	1
28	Kansas	Occidentalis	1892	May 30.	June 28.	Aug. 7.	1-12	1
29	Kenyon	Strigosus	1895					
30	London	Strigosus	1895					
31	Lovett	Occidentalis	1891	May 29.	July 1.	July 29.	1-14	1
32	Marlboro	Strigosus	1888	May 30.	June 26.	Aug. 7.	1-8	1
33	Miller	Strigosus	1895					
34	Mills 15	Occidentalis	1895					
35	Muskingum	Strigosus	1893	June 3.	June 28.	Aug. 5.	1-15	1
36	Nemaha	Occidentalis	1888	May 30.				
37	Ohio	Occidentalis	1888	May 29.	June 26.	July 29.	1-15	1
38	Older	Occidentalis	1893	May 28.	June 8.	July 25.	1-10	1
39	Palmer	Occidentalis	1890	May 24.	June 26.	July 31.	1-14	1
40	Progress	Occidentalis	1890	May 29.	June 28.	July 22.	1-18	5
41	Reeder	Strigosus	1888	May 31.	June 25.	Aug. 5.	1-9	3
42	Reliance	Strigosus	1888	May 31.	June 26.	Aug. 10.	1-10	1
43	Shaffer	Neglectus	1888	May 31.	June 28.	Aug. 5.	1-10	1
44	Smith Giant	Occidentalis	1894	May 29.	June 19.	Aug. 7.	1-12	4
45	Smith Prolific	Occidentalis	1894	May 30.	June 29.	July 17.	1-13	1
46	Souhegan	Occidentalis	1888	May 28.	June 25.	July 29.	1-14	2
47	Superlative	Strigosus	1895					
48	Thompson	Strigosus	1890	May 30.	June 21.	Aug. 5	1-12	2
49	Thwack	Strigosus	1895	May 31.	June 28.	Aug. 5.	1-18	4
50	Turner	Strigosus	1888	June 2.	July 1.	Aug. 10.	1-21	4
51	Tyler	Occidentalis	1888	May 25.	June 25.	July 19.	1-16	
52	Winona	Occidentalis	1895	May 29.	June 26.	July 31.	1-16	1
53	Wragg	Occidentalis	1895					

Special notices are appended of a few comparatively recent varieties, as well as of several older ones; some of them as worthy of increased attention by planters, while others are apparently unworthy.

American Everbearing black cap has been on trial here, for two years only. Thus far it has shown no everbearing tendency, nor does it otherwise give promise of valuable qualities.

Cardinal was received from Kansas, and has been noticed in previous reports as Greisa (the name of the introducer). It is intermediate, possibly a hybrid, between *strigosus* and *occidentalis*. It roots somewhat reluctantly, from both suckers and tips. It is hardy and fairly productive of more than medium sized fruit, though scarcely prolific enough to prove satisfactory as a market variety.

Champlain was only planted last spring and has barely shown a few imperfect specimens from the appearance of which, as well as from the habit of the plant, it is apparently identical with a variety grown here several years since and condemned as unworthy.

Church (Royal), a native of Ohio, was received in 1892. Although put forth with a "flourish of trumpets," it has not developed qualities such as would warrant a recommendation for extensive planting.

Conrath, a Michigan, *occidentalis* seedling, has already won more or less reputation as a profitable early market variety, comparing very favorably with others of its season, both as respects plant and fruit.

Cromwell, a Connecticut seedling, is much like the preceding in season, as well as in general character, though scarcely its equal in size of fruit.

Early King is apparently a variety of *strigosus*, possessing the vigor and hardiness of that species. So far it is productive of fruit of fine size and good quality.

Farnsworth was received from Ohio in 1891. It possesses valuable characteristics as a market blackcap, and is well worthy of trial for that purpose.

Gladstone, though bearing an honored name, has proved to be a disappointment. The fruit is far from attractive, in either appearance or quality. The young canes produce an autumn crop of fruit; a large proportion of which, however, in this climate, is usually ruined by frost before maturity.

Palmer is vigorous and productive. In weight of berry it is fully medium, while its bright color and good flavor render it very desirable for either family or market. It is early, though not the earliest.

Reeder (formerly *Reder*, by an error of the introducer), is still one of the most excellent red raspberries. So far as weight of berry, bright color and fine flavor are concerned, only needing greater vigor and productiveness to adapt it to commercial purposes.

Thwack was received last spring. It is an old variety, which was tested here ten or twelve years since, and although large, hardy, vigorous, productive and a good handler, it proved so utterly deficient in quality that it was dropped. It is yet occasionally planted for market.

BLACKBERRIES (*Rubus villosus*).

The stand of blackerries having been for several years in a very unsatisfactory condition, a new plat was planted last spring, which when well grown is intended to supersede the former one.

Blackberries having been sprayed on April 1, together with the entire plantation, were again treated on April 27 with a weaker solution, con-

sisting of one pound of copper sulphate in 250 gallons of water, to prevent anthracnose.

On May 23, anthracnose beginning to appear upon the young canes, the plat was treated with a spray of Bordeaux mixture, consisting of four pounds of copper sulphate and nine pounds of stone lime (that quantity proving necessary under the prussiate of potash test) in forty gallons of water.

On June 21 repeated the spray for anthracnose, using one and one-half ounces of copper sulphate dissolved in fifty gallons of water.

The only notable insect which has depredated upon the blackberry during the season is the leaf miner, *Tischeria malifoliella*, Clemens, which has proven increasingly troublesome for several years, and has this season become so numerous as to nearly or quite ruin a very large percentage of the foliage. So serious had the injury become that some means of preventing or exterminating it seemed indispensable.

Saunders, in "Insects Injurious to Fruits," at pages 114 and 115, notices the apple leaf miner as also attacking the foliage of the blackberry, this being assumed to be the insect in question, although this may be doubted since he does not accurately describe its habits as observed here, adding, moreover, "It has never been known to do any material injury."

Finding it indispensable that a remedy be applied, and observing that the larvæ were protected by the upper and lower tissues of the leaf between which they operate, it was obvious that no poisonous spray, whether caustic or otherwise, could effectually reach them. As a dernier resort, in view of this dilemma, the infected leaves were removed and burned, while the larvæ were yet at their work. Later a few leaves were again attacked. These were treated in the same manner.

The result of such treatment can only become manifest when it can be observed through its influence upon the growth of the coming year. Quite possibly a better knowledge of the life habits of the insect in its transformations might point to a more effective or economical method of attacking it.

BLACKBERRIES (*Rubus villosus*).

Number.	Name.	Planted.	First bloom.	First picking.	Last picking.	Weight of berry in ounces.	Quality—scale 1 to 10.	Productiveness—scale 1 to 10.
1	Agawam	1888	May 25.	July 12.	Aug. 1.	1-5	2	4
2	Ancient Briton	1888	May 28.	July 18.	Sept. 10.	1-8	7	2
3	Bonanza	1888	May 31.	July 18.	Sept. 14.	1-6	4	1
4	Childs	1892						
5	Early Cluster	1888	June 1.	July 13.	Aug. 16.	1.8	3	1
6	Early Harvest	1888	June 1.	July 8.	Aug. 26.	1-9	2	6
7	Early King	1890	June 1.	July 8.	Aug. 5.	1-7	2	4
8	Early Mammoth	1891	June 1.	July 13.	Aug. 31.	1-5	4	1
9	Eldorado	1893	May 30.	July 18.	Aug. 14.	1-7	4	1
10	Erie	1888	June 6.	July 20.	Aug. 1.	1-5	5	9
11	Fruitland	1892	June 6.	July 31.	Aug. 14.	1-8	5	6
12	Kittatinny	1888	June 1.	July 19.	Sept. 14	1-6	3	5
13	Knox	1888	May 31.	July 18.	Sept. 16.	1-6	3	1
14	Lawton	1888	June 1.	July 16.	Sept. 14.	1-6	3	6
15	Lincoln	1891	May 30.	July 16.	Aug. 24.	1-9	5	3
16	Maxwell	1894						
17	Minnewaska	1888	June 1.	July 18.	Aug. 31.	1-5	5	5
18	Nevada	1888	May 31.	July 15.	Sept. 12.	1-5	4	1
19	Ohmer	1892	June 6.	July 17.	Aug. 31.	1-6	3	5
20	Oregon (Everbearing)	1892	May 31.	July 25.	Sept. 14.			
21	Sanford	1894						
22	Snyder	1888	May 28.	July 13.	Sept. 7.	1-10	1	1
23	Stone	1890	May 30.	July 19.	Aug. 16.	1-10	5	4
24	Taylor	1888	May 31.	July 17.	Sept. 15.	1-11	1	4
25	Thompson	1890	May 31.	July 18.	Aug. 24.	1-5	5	4
26	Wachusett	1890	May 29.	July 13.	Aug. 7.	1-16	3	1
27	Wallace	1888	May 29.	July 16.	Sept. 12.	1-8	3	3
28	Western Triumph	1888	May 31.	July 15.	Aug. 14.	1-8	4	1
29	Wilson	1888	May 30.	July 13.	Aug. 26.	1-4	5	4
30	Wilson Jr.	1888	May 31.	July 18.	Aug. 26.	1-5	5	4

Ancient Briton and Western Triumph are both vigorous and hardy, though small and inclined to overbear. The former is popular at the west, as a market variety. Both require superior cultivation and close pruning to maintain an acceptable size for market.

Bonanza, Early Cluster and Nevada have given better results this year than usual. Childs, thus far has given little indication of value. Having been transplanted last spring, it has not yet shown fruit.

Early Harvest was badly injured by cold last winter. It must have winter protection to succeed even in our lake shore climate.

Early King and Early Mammoth are comparatively recent varieties, usually quite productive of fine sized fruit. They are apparently well worthy of trial for market, though they may perhaps prove deficient in hardiness.

Eldorado, Lincoln and Ohmer have been too recently planted here to warrant a conclusion, as to their measure of success, although they are well spoken of in certain other localities.

Maxwell, Piasa and Sanford were first planted here last spring, and must therefore have further opportunity to develop their characteristics.

Oregon (Everbearing) is a curiosity, with cut-leaved foliage, a vigorous, semi-trailing habit of growth, blooming and fruiting in succession.

Stone (Hardy) is a vigorous, spreading grower, said to be unusually hardy. As generally grown its fruit is quite too small for either home use or market.

Wachusett (and Hoosic also) is chiefly notable for the absence of spines; although the Wachusett is of fine flavor. Both are quite too small. So far no spineless variety of practical value has been introduced to the public.

SERVICE BERRY (*Amelanchier*).

Only three varieties of this species, all of them of dwarf habit, have so far been planted here. These are, an unnamed variety, designated in our lists as common, one known as Success, and one received from Indiana as Mammoth.

So far as either plants or fruits are concerned, the difference between these alleged varieties, as grown here, is very slight, if even perceptible.

The fruit is so specially attractive to birds that the entire crop is invariably appropriated by them, even before fully ripe, unless protected by netting or otherwise. Indeed, so decided is such preference, that this fruit might perhaps be profitably planted as the means of diverting the attention of the birds from other fruits of similar season.

In quality, this fruit is by no means equal to the huckleberry, which it closely resembles.

CURRANTS (*Ribes*).

A new plantation of currants was made last spring, as far as plants were available for the purpose, and at the same time the plants in the old plat were earthed up, to insure the rooting of sufficient additional plants for the filling up of the new plat next spring.

On March 18, while yet dormant, currants (in common with the entire plantation), were sprayed with a solution of two pounds of copper sulphate in 50 gallons of water.

On April 27, being now in foliage, they were again sprayed with a solution of one pound of copper sulphate in 250 gallons of water.

On May 8, the currant worm (*Nematus ventricosus*) having attacked the foliage, the infected plants were treated with a spray consisting of one pound of Paris green in 250 gallons of water.

May 27. Previous season's trials having shown that liver of sulphur (potassium sulphide), the antidote for gooseberry mildew, is also a preventive of the premature loss of currant foliage, the spray of this preparation was also applied to the currant, and this was repeated on June 4, June 19, and July 5.

Later a spray of buhach in water was applied to subdue the second brood of currant worms, which appeared just as the fruit was ripening.

Aside from the currant worm already referred to, the twig borer (*Ægeria tipuliformis*) has been the only troublesome insect this year. A careful search for this insect will scarcely be made prior to the pruning, next spring, though the indications are that (owing doubtless to persistent efforts for its destruction during the past two or three years) its numbers may prove to have considerably diminished.

In the following table, in the column of weights of single berries, expressed in fractions of an ounce, it will be seen that in all cases the denominator of the fraction gives the number of berries in an ounce. The extreme drouth of the season doubtless considerably diminished the weights as recorded. The quality and productiveness given are *relative*, being arrived at by comparing each with others of the same species.

CURRANTS (*Ribes*).

Number.	Name.	Species.	Planted.	Bloomed.	Ripened.	Weight of berry in ounces.	Quality—scale 1 to 10.	Productiveness—scale 1 to 10.
1	Champion (Black)	Nigrum	1889	May 2	June 27	1-17	1	4
2	Cherry	Rubrum	1888	May 1	June 21	1-28	3	3
3	Crandall	Aureum	1889	May 1	July 2	1-20	10	2
4	English (Black)	Nigrum	1892	May 3	June 29	1-18	5	4
5	Fay	Rubrum	1888	May 1	June 21	1-27	3	3
6	Holland (Long Bunched)	Rubrum	1889	May 2	June 24	1-44	5	2
7	Knights (Improved)		1895					
8	Lakewood	Rubrum	1890	May 1	June 21	1-25	3	6
9	Lee	Nigrum	1888	May 3	June 29	1-21	7	2
10	London (Red)	Rubrum	1890	May 2	June 22	1-37	6	2
11	Moore Ruby	Rubrum	1890	May 1	June 21	1-32	2	2
12	Moore Select	Rubrum	1890	May 2	June 21	1-35	5	2
13	Naples (Black)	Nigrum	1888	May 3	June 29	1-37	5	5
14	North Star	Rubrum	1890	May 1	June 21	1-45	3	1
15	Red Dutch	Rubrum	1888	May 1	June 22	1-18	2	2
16	Ruby Castle	Rubrum	1892	May 1	June 21	1-45	4	1
17	Saunders	Nigrum	1890	May 4	June 29	1-28	7	4
18	Versaillaise	Rubrum	1888	May 1	June 21	1-39	3	3
19	Victoria	Rubrum	1888	May 1	June 21	1-41	5	2
20	Wales (Prince of)	Nigrum	1890	May 4	June 29	1-15	7	4
21	White Dutch	Rubrum	1888	May 1	June 21	1-44	1	2
22	White Gondoin	Rubrum	1890	May 2	June 18	1-30	1	1
23	White Grape	Rubrum	1888	May 2	June 21	1-38	2	1
24	Wilder	Rubrum	1890	May 1	June 29	1-30	3	3

Cherry is large but with short clusters, quite acid, but popular on account of its large size. An indifferent grower.

Crandall, a variety of the old yellow flowering currant, though large is of no practical value. It has been omitted in our recent planting.

Fay is much like Cherry in both plant and fruit. It apparently requires superior culture to fully develop its best characteristics.

Holland (Long Bunched) is the most vigorous variety in our collection. It holds its foliage more persistently than any other variety, if we except the Victoria. It is late in ripening, with long bunches but small berries. Productive.

Lakewood is a recent Ohio variety which, so far, has shown few valuable qualities.

London (Red) is supposed to be identical with London Market; it is vigorous and very productive, and though neither large nor of high quality, is a profitable market variety.

Naples (Black) is very vigorous and productive. It has long been considered the leading market variety of its species.

North Star, a recent Minnesota variety, is exceedingly vigorous and said to be productive, a characteristic not yet determined so far as this locality is concerned. The clusters are long, but, so far, the berries are not large.

Red Dutch, so far, everything considered, has no superior among red varieties.

Victoria, on account of its partial exemption from the attacks of the twig borer (*Ægeria tipuliformis*) is the leading commercial variety in localities in which that insect is troublesome. It is slightly late in ripening and retains its foliage longer than most varieties.

Wales (Prince of), a comparatively recent variety of *nigrum*, although less productive, has this year produced longer specimens than any other of its species.

White Dutch and White Gondoin are very similar. In mild, rich flavor they have so far no superior.

Wilder has been grown here several years, without developing specially valuable qualities, although in a few other localities it has recently been highly commended.

GOOSEBERRIES (*Ribes*)

Gooseberry and currant rows being adjacent have received the same treatment, so far as spraying is concerned, and since both are alike subject to the attacks of the currant worm (*Nematus ventricosus*), their treatment for this malady was also the same, excepting only the Industry gooseberry, which on June 21 was treated with a spray of zenoleum (a preparation manufactured by a Detroit firm and represented as a non-poisonous insecticide, fungicide and disinfectant). The application was effective against the mildew, for which purpose it was applied.

The liver of sulphur applied as stated under the head of currants, has apparently proved to be a specific in both cases, except that in the case of a plant or two of Triumph gooseberry, under the shelter of some evergreens, spoken of in last year's report, which perchance lacking free exposure should, for this reason, have received unusually thorough treatment.

The crumpling of the terminal leaves, mostly of such varieties as Houghton and Pale Red, has again appeared this year. It is supposed to be the work of a minute aphid, which attacks the under side of the leaves and which, in consequence, are drawn so compactly together that a spray can scarcely be made to penetrate the mass effectively. The remedy resorted to has been to cut away and burn the affected tips. The attack this year has apparently been less severe than heretofore.

Except as noted, the gooseberry has been exempt during the season from serious attacks of either insects or fungi.

As in the case of currants, the plants were "earthed up" last spring for the purpose of securing rooted plants to be used next spring in completing a new plantation of this fruit, with a more even stand of plants, for this reason better adapted to Station purposes

GOOSEBERRIES (*Ribes*).

Number.	Name.	Species.	Planted.	Bloomed.	Ripened.	Weight of berry in ounces.	Quality—scale 1 to 10.	Productiveness—scale 1 to 10.
1	Apex	Cynosbati	1893	May 2	Aug.	1-6	2	
2	Auburn	Grossularia	1890	May 3	July 2	1-21	1	7
3	Bendelon	Grossularia	1894			1-7		
4	Champion	Grossularia	1891	May 2	July 2	1-6	2	2
5	Chautauqua	Cynosbati	1892	May 2	July 2	1-4	2	
6	Columbus		1895					
7	Downing	Cynosbati	1888	May 2	July 8	1-8	4	1
8	Golden (Prolific)	Grossularia	1891	May 2				
9	Houghton	Hirtellum	1888	May 2	July 2	1-13	1	1
10	Industry	Grossularia	1889	May 2	July 1	1-2	3	1
11	Keepsake	Grossularia	1894	May 2				
12	Lancashire (Lad)	Grossularia	1894	May 2				
13	Orange (Early)	Grossularia	1890	May 2	June 24	1-5	2	4
14	Pale Red	Hirtellum	1890	May 2	July 1	1-13	1	1
15	Pearl	Grossularia	1890	May 3	July 2	1-7	1	1
16	Red Jacket	Grossularia	1890	May 2	June 8	1-4	2	4
17	Smith	Cynosbati	1888	May 2	June 28	------	1	5
18	Strubler	Cynosbati	1892	May 2				
19	Tree	Cynosbati	1892	May 2	July 16	1-14	3	5
20	Triumph	Grossularia	1890	May 2	July 16	1-3	3	3

Apex, a native of Oregon, has the habit and foliage of the Europeans, though apparently distinct in fruit. It is yet too soon to have properly manifested its peculiarities.

Auburn is a name temporarily applied to an unknown foreign variety of excellent quality, early, and of large size.

Bendelon (the name of the person from whom the variety was received), is an untested seedling of foreign parentage, originated at Detroit, Michigan.

Champion, Industry, Pearl and Triumph are all of European extraction and have been sufficiently tested here to justify their commendation for extended trial, but only with persistent spraying to ward off the attacks of mildew.

Chautauqua, though highly spoken of elsewhere, requires farther trial here.

Columbus, Golden (Prolific), Keepsake, Lancashire (Lad), and Orange (early), are all understood to be of foreign parentage. With persistent spraying they have so far escaped mildew, but farther trial is needful to determine their value here.

Downing is beyond doubt the most popular of our alleged native varieties, for commercial planting, though not of superior flavor. Smith is even larger and of superior quality, but the plant lacks vigor and productiveness.

Houghton and Pale Red are much alike, so far as both plant and fruit are concerned. They are healthy and vigorous, though of slender habit, but the fruit, though abundant and of good quality, is quite too small to suit the popular taste.

Red Jacket, judging from the habit of the plant and the size and general appearance of the fruit, though an American seedling, is probably of

foreign parentage. With persistent spraying it is healthy and vigorous and the fruit of fine size. Farther trial is needful.

Strubler, from Illinois, and Tree from Ohio, are unmistakable natives, healthy and vigorous, but have yet to develop their full qualities here.

CHERRIES (*Prunus*).

Notwithstanding the renewal and even the increased intensity of the drouth of the past season, as compared with that of 1894, frequent and thoroughly clean cultivation has sufficed, in the case of the cherry, as also with the other tree fruits, to secure a very satisfactory growth of wood, as well as a fair development of fruit upon such trees as were in bearing. Even the few trees which, up to last year, had failed to repair the injury due to the excessively wet spring of 1893, have now so far improved as to afford the promise of permanent recovery.

After the spray applied to cherries in common with other fruits in March last, farther treatment was not found needful till June 24, when cherries (and pears also), were given a spray of strong tobacco water, as a remedy for the slug (*Eriocampa cerasi*), which made its first appearance at that time. A very few appeared subsequently, but yielded readily to a repetition of the same treatment. Except as already described, neither insects nor fungi have been observed to attack the cherry, either tree or fruit, the curculio apparently having confined his attention to early peaches and plums.

In the following table the quality of the fruit is arrived at by comparing each variety with others of its species, as Duke varieties with Dukes, Morellos with Morellos, etc.

Under the head of weight, as in the case of small fruits, it will be observed that the denominator of the fraction gives the number of fruits in an ounce.

The degree of productiveness as given under that head, has reference to the product of the year 1895 only.

CHERRIES (*Prunus*).

Number.	Name.	Species.	Planted.	Bloomed.	Ripened.	Weight of fruit in ounces.	Quality—scale 1 to 10.	Productiveness—scale 1 to 10.
1	Abbesse	Morello	1888	May 2	July 8	1-8	2	8
2	Angouleme	Morello	1888	May 2	July 8	1-5	2	5
3	Badacconyi	Avium	1894	May 4				
4	Baender	Morello	1892	May 3				
5	Bessarabian	Morello	1888	May 2	June 26	1-7	2	2
6	Brusseler Braune	Morello	1888	May 3	June 26	1-7	1	2
7	Carnation	Duke	1891	May 3	June 24	1-4		
8	Centennial	Avium	1893	May 4				
9	Choisy	Duke	1888	May 2	June 20	1-5	----	6
10	Cleveland	Avium	1891	May 2	June 19	1-4		
11	Coe (Transparent)	Avium	1888	May 2	June 20	1-4	----	7
12	Downer	Avium	1888	May 2	July 1	1-5	----	7
13	Dyehouse	Morello	1891	May 3	June 12	1-9	----	8
14	Eagle (Black)	Avium	1888	May 1	June 28	1-5	2	5
15	Early Purple	Avium	1892					
16	Elton	Avium	1892	May 2	June 18	1-4		
17	Esperen	Morello	1892	May 3				
18	Eugenie	Duke	1888	May 2	June 18	1-5	----	6
19	Everbearing	Morello	1892	May 3				
20	Florence	Avium	1892	May 3				
21	Frauendorfer Weichsel	Morello	1888	May 2	July 8	1-	1	2
22	Galopin	Morello	1891	May 3				
23	Geo. Glass	Morello	1888	May 3	July 2	1-8	5	5
24	Griotte du Nord	Morello	1888	May 3	July 18	1-7	4	5
25	Hortense	Duke	1888	May 2		1-5	3	8
26	Ida	Avium	1893	May 4				
27	King Amarelle	Morello	1891	May 3	June 18			
28	Knight Early	Avium	1891	May 3				
29	Late Duke	Duke	1890	May 3				
30	Lithauer Weichsel	Morello	1892	May 3	July 10	1-8	3	1
31	Lutovka	Morello	1888	May 3	July 8	1-4	2	4
32	Magnifique	Duke	1888	May 4	July 18	1-5	3	9
33	Mahaleb	Mahaleb	1893	May 4				
34	Mary (Kirtland)	Avium	1891	May 2	June 18	1-4		
35	Mastodon (Black)	Avium	1893	May 4				
36	May Duke	Duke	1888	May 2	June 18	1-5	2	7
37	Mezel	Avium	1891	May 2	June 18			
38	Minnesota (Ostheim)	Morello	1892	May 3	June 29	1-6	5	4
39	Montmorency	Morello	1888	May 3	June 17	1-7	----	2
40	Montmorency, Ordinaire	Morello	1891	May 3	June 25	1-6		
41	Montreuil	Duke	1890	May 3	June 26	1-5	5	2
42	Napoleon	Avium	1893	May 2	June 24	1-4		
43	Northwest	Morello	1893	May 4	July 8	1-12	4	1
44	Ohio (Beauty)	Avium	1891	May 3				
45	Olivet	Duke	1890	May 2	June 24	1-4	----	6
46	Orel 25	Morello	1893	May 4				
47	Orel 27	Morello	1893	May 4				
48	Ostheim	Morello	1891	May 2	July 1	1-11	5	2
49	Ostheimer	Morello	1893	May 4	July 12	1-8	6	
50	Phillippe (Louis)	Morello	1888	May 2	June 24	1-4	4	3
51	Richmond	Morello	1892	May 2	June 20	1-7	3	1
52	Rockport	Avium	1891	May 2	June 14	1-4		
53	Royal Duke	Duke	1891	May 3				
54	Sklanka	Morello	1888	May 2	June 17	1-6	----	3
55	Spate Amarelle	Morello	1888	May 3	July 2	1-7	5	6
56	Strauss Weichsel	Morello	1888	May 2	June 27	1-5	3	4
57	Suda	Morello	1893	May 4	July 15	1-5	3	1
58	Tartarian (Black)	Avium	1888	May 2	June 24	1-3	3	6
59	Wier	Morello	1893	May 4	June 22	1-7		
60	Windsor	Avium	1891	May 3	June 23	1-4		
61	Wood (Gov.)	Avium	1891	May 2	June 18	1-5		
62	Wragg	Morello	1892	May 4	July 1	1-6	6	3
63	Spanish (Yellow)	Avium	1891	May 2	----------	1-4	1	6

Abbesse, Angouleme, Bessarabian, Brusseler Braune, Frauendorfer Weichsel, George Glass, Griotte du Nord, Lithauer Weichsel, Lutovka, Sklanka, Spate Amarelle, and Strauss Weichsel were all received from Prof. Budd of Iowa Agricultural College, and are understood to be among those imported by him from eastern Europe.

Of the above Abbesse is, so far here, a slow, weak grower and a moderate bearer of rather small, acid fruit.

Sklanka, another of these, is a moderately vigorous grower, in habit of growth and productiveness, as well as in quality of fruit much like Montmorency.

The remaining ones are vigorous growers, generally rather upright for Morellos, ripening from late to very late; the fruit of good size, dark color and acid. So far they have improved from year to year in productiveness and size of fruit. They are apparently slow in developing their characteristics in these respects.

Badacsonyi, Baltavari, and Moduyansky, apparently of the sweet or *avium* class, received through the Department of Agriculture from southeastern Europe, may be expected to fruit here next season.

Baender, Everbearing, Galopin, King Amarelle, Minnesota (Ostheim) Northwest, Orel 25, Orel 27, Ostheim, Ostheimer, Suda, and Wier 2, have been received at sundry times from various sources. All are Morellos and several are known, while others are believed, to be of western origin. Nearly all have now fruited here, but many of them so lightly that special notices and descriptions are deferred till they shall have more fully developed their respective qualities.

Carnation has so far proved a shy bearer, though a vigorous grower.

Centennial and Mastodon (Black) are understood to be California seedlings, of the *avium* class. They have not yet shown fruit here.

Choisy, a duke, though but a moderate bearer, is one of the most beautiful and excellent of cherries. Where the dukes succeed no farmer's or amateur's garden should be without a tree or two of this variety.

Cleveland, Downer, Napoleon, Rockport, Tartarian (Black), and Wood (Gov.) are all valued as market varieties, where the sweet cherries are employed for this purpose.

Coe (transparent), very beautiful and excellent, also Eagle (Black), Early Purple, are of the earliest, with Elton, Florence, Ida, Knight Early, Mary (Kirtland), and Mezel are all more or less popular amateur, sweet varieties. They require farther trial here prior to comparative characterization.

Dyehouse is an early and productive Morello, with a very slender, drooping habit. Neither tree nor fruit has much, aside from earliness and productiveness, to recommend it.

Esperen, though it bloomed last spring, has not yet fruited here. It has the habit of growth of the Morellos.

Eugenie is a fine duke variety, which apparently deserves more attention than it has yet received. The fruit is excellent, though its productiveness here cannot yet be vouched for.

Hortense is vigorous and productive, and the fruit large and excellent. In season it is about medium.

Late Duke is an old variety, which has not so far been largely planted. Apparently it lacks productiveness.

Magnifique is desirable on account of its extreme lateness as well as its fair size and quality. Its reputation for productiveness here is yet to be established.

Mahaleb is the stock, largely used by nurserymen, on which to work cherries. Its fruit is of little account. The dwarfing influence of this, when employed as a stock, appears to be more a myth than a reality.

May Duke is the type of its class. It is too well known and valued to need either description or characterization.

Montmorency, Montmorency Large and Montmorency Ordinaire seem to need investigation. Whether there really are three varieties as would appear from current nursery catalogues, or two only, or in fact but one, seems uncertain. Montmorency Large received here from a prominent eastern establishment, proves to be Dyehouse.

Montreuil is an early and prolific bearer of good quality, apparently only second to the May Duke.

Olivet promises well but requires farther trial here.

Phillippe (Louis), is every way highly satisfactory, save that it sadly lacks the essential quality of productiveness.

Richmond (the Kentish of Downing) is universally known as a leading market, culinary cherry, although Montmorency is to some extent, superseding it.

Rocky Mountain (Dwarf) has recently been widely and apparently extravagantly lauded. Those tested here are very dwarf and have borne while very young, but the fruit is utterly worthless.

Royal Duke is an old variety, which seems never to have attracted much attention. Experience here so far would seem to justify this.

Windsor, a recent, late, sweet cherry, orginating near Windsor, opposite Detroit, has fruited here twice, though but lightly. It promises well as a hardy variety.

Wood (Governor) is valued as a market sweet cherry for localities adapted to this species.

Wragg, originated in Iowa, is popular as an acid cherry, where superior hardiness is requisite. Here it proves to be a slow grower and quite late, though an early and productive variety.

Spanish (Yellow) (Bigarreau of Downing) is the type of the class of firm fleshed, sweet cherries. It is not even yet excelled in high quality. But for its unfortunate tendency to crack and decay in case of warm, moist weather during the ripening season, it would doubtless even yet hold a leading position in its class.

MULBERRIES (*Morus*).

The varieties of mulberry which ripen their fruits in succession, during several weeks and hence are said to be everbearing, are the only ones grown here for trial.

Of these Downing is very vigorous, though scarcely hardy, even at the lake shore.

New American is hardy, vigorous and productive.

Hicks is a southern variety, evidently out of its proper latitude here.

Russian is a spreading, drooping variety, valuable, if at all, on account of its hardiness, for screens or windbreaks. Its fruit, though abundant, is of no value.

Teas Weeping when grafted upon upright stocks of suitable height, makes one of the finest of weeping trees.

PEACHES (*Prunus Persica, Amygdalus Persica or Persica vulgaris*, of various botanists).

A large number of varieties of peaches have fruited here this season, many of them for the first time. Of these an unexpectedly large number have proved spurious, indicating an inexcusable amount of error, carelessness or worse. So far the proportion of error proves to be far greater among peaches than with other classes of fruits. This is stated the more confidently with the hope to induce increased carefulness. The practice here is to keep an accurate record of the source from which each tree is received. A careful description is also made of both fruit and tree of each variety when at maturity.

On April 1 to 6 peaches in common with all other tree fruits, were sprayed with a solution of two pounds of copper sulphate in fifty gallons of water.

On May 15 peaches were sprayed to prevent leaf curl, using a solution of one pound of copper sulphate in 500 gallons of water.

Early in May the peach trees were "wormed" to eradicate the larvæ of the borer, which had escaped the scrutiny of the previous autumn, and the process was repeated in the following September to dispose of the current season's colony.

On May 29, commenced jarring trees for curculio, but so far as peaches were concerned it was mainly confined to the early, smooth skinned varieties. Even this was soon found to be unnecessary, the attacks of the insect being mainly confined to the adjacent plums.

A few rose chafers were also caught upon peaches, when jarring for curculios, though their depredations were mainly confined to the plum.

The spray to prevent curl leaf was apparently unnecessary, since the disease so prevalent in other years has this season been conspicuously absent, even in unsprayed orchards.

As has been stated in previous reports, the fungus usually so injurious to the young wood and foliage of serrate peaches, has been found to be amenable to a spray of Bordeaux mixture. This fungus also has been entirely absent during this year.

Except as already noted, neither fungi nor insects have been observed attacking the peach during the season.

As a remedy for the unprecedented drouth the soil has been kept mellow by the persistent use of the cultivator, with the effect that the trees have been maintained in vigorous growth and their fruit developed more perfectly than had been anticipated.

The productiveness as given in the following table is that of the current season. It is given without regard for the size, age or condition of the trees.

Many of the varieties on trial and noted in the following tables were received without history or description, and hence with no possible means of determining their identity. In a few cases their identity or incorrectness has incidentally betrayed itself. Quite possibly, however, other cases of spuriousness yet remain undetected.

PEACHES.

Number.	Name.	Planted.	Bloomed.	Flowers—l, large; m, medium; s, small.	Glands—g, globose; r, reniform; s, serrate.	Ripened.	Adhesion—c, cling; f, free; s, semi cling.	Weight of fruit in ounces.	Productiveness—scale 1 to 10.
1	Adrian	1892	May 3	l	g				
2	Alberge	1893	May 4	s	r	Aug. 28	f	4	6
3	Albright	1890	May 3	s	g	Sept. 24	f	5	6
4	Alexander	1893	May 3	l	g	July 27	s	3½	10
5	Allen (Stark)	1890	May 3	s	r	b. m. Oct	f	5	3
6	Allen (Taft)	1890	May 3	s	r	Sept. 7	f	4	6
7	Allen (Cleffey), See 39	1890	May 3	s	r	Sept. 7	f	4½	6
8	Alpha	1890	May 3	s	r	Sept. 3	c	5	10
9	Amelia (Carolina)	1890	May 3	s	r	Aug. 24	f	4	9
10	Amsden	1890	May 3	l	g	July 22	s	4	3
11	Andrews	1890	May 3	l	r				
12	Arctic	1894	May 2	l	r				
13	Barber	1893	May 3	l	r	m.e. Sept	f	5	2
14	Beers Smock	1890	May 3	s	r	b. m. Oct	f	5½	5
15	Bell (Fav.)	1890	May 3	s	r	Sept. 19	f	5	10
16	Bequette (Free)	1890	May 3	s	r	Sept. 12	f	5½	2
17	Berenice	1894	May 3	------	r				
18	Bickell	1890	May 3	s	r	m. Oct.	f	3	1
19	Bishop	1890	May 3	s	g	Aug. 14	f	4	1
20	Blood Leaf	1890	May 2	l	r	b. Oct.	c	2¼	4
21	Bonanza	1890	May 3	s	r	m. e. Oct	f	3	3
22	Boyle	1890	May 3	s	g	Sept. 3	f	3	1
23	Brandywine	1890	May 3	s	g	Sept. 25	f	5	7
24	Brett	1890	May 4	s	r	e. Oct.	c	3½	4
25	Brigdon (Garfield)	1890	May 3	s	g	Sept. 3	f	3½	6
26	Briggs	1890	May 3	s	g	Sept. 3	f	4	6
27	Brunson	1894	May 2	s	r	Sept. 12	f	2¾	1
28	Brown	1894	May 2	l	r	Aug. 19	f	3	1
29	Burke	1892	May 3	l	r	Sept. 18	s	5	7
30	California	1895	May ---	------	r				
31	Canada	1892	May 2	l	g	July 25	s	4	1
32	Chair	1890	May 3	s	r	Sept. 27	f	4½	4
33	Champion (Ill.)	1892	May 2	s	g	Aug. 27	f	5	10
34	Champion (Michigan)	1890	May 3	l	s	July 27	s	4	5
35	Chili (Hill)	1888	May 3	l	r	Sept. 10	f	3	1
36	Chili 2 (Engle)	1888	May 2	s	r	Sept. 14	f	5	1
37	Chili 3 (Engle)	1888	May 2	s	r	Sept. 14	f	4	1
38	Chinese Cling	1890	May 3	l	r	b.m. Sept	c	5½	3
39	Cleffey (Allen)	1892	May 3	s	r	Sept. 7	f	4½	6
40	Columbia	1890	May 3	l	r	Sept. 26	f	4	3
41	Conkling	1890	May 3	s	r	Sept. 17	f	4	4
42	Connett	1891	May 3	l	r				
43	Coolidge (Mammoth)	1892	May 3	s	g	Sept. 19	f	6	6
44	Corner	1890	May 3	s	r	Sept. 11	f	4	2
45	Crosby	1892	May 3	s	r	Sept. 24	f	4	5
46	Caruthers	1890	May 3	s	g	Sept. 17	f	4	1
47	Dennis	1890	May 3	l	g	Sept. 4	f	2⅓	1
48	Diamond	1892	May 4	s	g	----------	------	------	10
49	Druid Hill	1890	May 3	s	g	Sept. 23	f	5	7
50	Dumont	1894	May 6	s	r				
51	Dunlap	1893	May 3	s	r	Sept. 1	f	5½	2
52	Dwarf Cuba	1892	May 4	s	r				
53	Early Barnard	1888	May 2	s	r	Aug. 29	f	4	1
54	Early Crawford	1888	May 2	s	g	Aug. 28	f	6	4
55	Early Crawford 1	1888	May 2	s	g	Aug. 29	f	4	3

PEACHES.—CONTINUED.

Number.	Name.	Planted.	Bloomed.	Flowers—l, large; m, medium; s, small.	Glands—g, globose; r, reniform; s, serrate.	Ripened.	Adhesion—c, cling; f, free; s, semi cling.	Weight of fruit in ounces.	Productiveness—scale 1 to 10.
56	Early Crawford 3	1888	May 2	s	g	Sept. 6	f	4½	2
57	Early Michigan 15	1894	May 2	l	g	Aug. 27	f		
58	Early Michigan 16	1894	May 2	l	r	Aug. 27	f	4	1
59	Early Silver	1888	May 2	l	r	Sept. 3	f	3	1
60	Ede	1890	May 3	s	r	Sept. 13	f	6	3
61	Elberta	1890	May 3	s	r	Sept. 11	f	6	2
62	Ellison	1889	May 3	s	r	Sept. 24	f	3	2
63	Engle (Mammoth)	1892	May 3	s	g	Sept. 3	f	4	3
64	Ford New	1894	May 3	s	g				
65	Ford Red	1894	May 2	s	g				
66	Ford 1	1894	----	----	r	Aug. 14	s	3½	
67	Ford 2	1894	May 3	s	g				
68	Ford 3	1894	May 4	s	r				
69	Ford 7	1894	May 2	l	r				
70	Foster	1888	May 2	s	g	Aug. 24	f	4	4
71	Fox	1890	May 3	s	g	Sept. 24	f	5	3
72	Garfield (See Brigdon)	1892	May 3	s	g	Sept. 5	f	4	10
73	Geary (Hold on)	1890	May 3	s	r	b.m. Oct.	f	5	4
74	Gem Cling (No. 5)	1890	May 3	s	r	Sept. 20	c	7	1
75	Globe	1888	May 3	s	g	Sept. 12	f	7	8
76	Gold Drop	1890	May 3	l	r	Sept. 18	f	4	1
77	Grant (General)	1890	May 3	s	r	Sept. 27	c	4½	8
78	Great Western	1892	May 2	s	r	m.e.Oct.	c	4	10
79	Gudgeon	1890	May 3	s	r	b.m.Oct.	f	4	4
80	Haas	1890	May 3	l	r	Aug. 13	f	3	2
81	Hale	1888	May 2	l	g	Aug 10	s	2½	1
82	Hale Cross 1	1888	May 3	l	g	Aug. 8	s	2	1
83	Hance Golden	1890	May 3	s	g	Sept. 7	f	4	6
84	Hance Smock	1890	May 3	s	r	b.m.Oct.	f	4½	3
85	Heath Cling	1890	May 3	s	r	m.e.Oct.	c	6	10
86	Hughes IXL	1892	May 3	l	r	----	----	----	10
87	Hyatt	1888	May 2	l	g	Aug. 10	s	2½	1
88	Hynes (Surprise)	1890	May 3	s	g	Aug. 10	f	2¾	5
89	Hyslop	1892	May 2	s	r	Sept. 24	c	5	
90	Ice Mountain	1894	May 3	l	r				
91	Infant Wonder	1892	May 2	s	g	Sept. 3	f	4	1
92	Iron Mountain	1891	May 3	----	r				
93	Jacques Late	1890	May 3	s	g	----	----	----	5
94	Japan Dwarf	1894	May 1	l	r				
95	Jersey Yellow	1895	May 3	----	r				
96	Jones	1892	May 3	s	g	Sept. 17	f	6	10
97	June Rose	1894	May 2	l	g	Aug. 28	f	4	1
98	Juno	1894	----	----	r				
99	Kalamazoo	1890	May 3	s	r	Sept. 12	f	4	1
100	Kallola	1892	May 2	l	r	Sept. 17	f	5	4
101	La Fleur	1894	May 2	l	r				
102	Late Barnard	1891	May 2	l	r	Sept. 12	f	4	2
103	Late White	1889	May 2	s	r	Sept. 24	f	4	1
104	Lemon Cling	1888	May 4	s	g	Sept. 10	c	4	2
105	Lemon Free	1894	May 2	l	r				
106	Lewis	1890	May 3	l	r	Aug. 14	f	3	1
107	Lock Cling	1892	May 3	s	r	Oct. 22	c	4	8
108	Longhurst	1894	May 2	l	r				
109	Lovell	1894	May 2	s	g	Sept. 19	f	4	1
110	Lovett (White)	1890	May 3	s	r	Sept. 24	f	5	5

PEACHES.—CONTINUED.

Number.	Name.	Planted.	Bloomed.	Flowers—l, large; m, medium; s, small.	Glands—g, globose; r, reniform; s, serrate.	Ripened.	Adhesion—c, cling; f, free; s, semi cling.	Weight of fruit in ounces.	Productiveness—scale 1 to 10.
111	Magdala	1890	May 3	s	r	Aug. 28	f	3¾	2
112	Marshall	1890	May 3	s	r	b.m.Oct.	------	4½	3
113	McCollister	1892	May 2	s	r	Sept. 24	f	6	3
114	McKevitt (Cling)	1892	May 3	s	g	b.m.Oct.	c	4	
115	Milhizer	1892	May 2	s	g				
116	Minnie	1892	May 4	s	r	Aug. 28	f	4¾	9
117	Moore	1890	May 4	s	g	Sept. 10	f	4	4
118	Morris Co.	1890	May 4	s	r	b.m.Oct.	f	4	1
119	Morris White	1888	May 2	s	r	Sept. 10	f	3	1
120	Mountain Rose	1888	May 2	s	g	Aug. 17	f	4	1
121	Muir	1890	May 4	l	r	Sept. 12	f	7½	1
122	Murat	1889	May 2	s	r	Sept. 24	f	4	1
123	Mystery	1888	May 3	s	r	Aug. 19	f	5	6
124	N. Am. Apt.	1892	May 3	l	r	Sept. 17	f	5	9
125	Nectarine	1889	May 2	l	r	Sept. 10	f	3	2
126	Need (Barnard)	1890	May 3	s	r	Aug. 31	f	3½	2
127	Neil (Marshall)	1892	May 2	l	r	Oct. 2	f	4¼	6
128	Newington free	1893	May 3	s	r				
129	New Prolific	1894	May 2	s	g				
130	Normand	1892	May 4	s	r	m.e.Oct.	c	4½	10
131	Oldmixon cling	1888	May 2	s	g	Sept. 7	c	3	1
132	Oldmixon free	1893	May 2	s	g	Sept. 12	f	7	
133	Oriole	1894	May 2	l	r				
134	Oscar	1894	----------	------	------	b.m.Sep.			
135	Ostrander	1892	May 3	s	g	Aug. 20	f	3½	5
136	Pallas	1894	May 3	l	g				
137	Palmerston	1890	May 3	l	g	Sept. 23	f	8	4
138	Pansy	1890	May 4	s	r	Aug. 15	f	4	10
139	Pearl	1889	May 2	s	g	Sept. 10	f	3½	2
140	Peninsular (Yellow)	1894	May 3	s	g				
141	Pickett	1890	May 3	l	r	b.m.Oct.	c	4½	8
142	Pratt	1890	May 3	s	r	Sept. 3	f	3	4
143	Prince (R. R.)	1890	May 3	s	g	Sept. 6	f	4½	5
144	Princess	1894	May 3	l	g				
145	Princess (of Wales)	1889	May 2	l	g	m.e.Sep.	f	7	1
146	Prize	1892	May 2	s	g	Sept. 24	f	5	9
147	Prize 1	1890	May 4	s	r	Sept. 18	f	4	1
148	Red Cheek (Neal.)	1893	May 3	s	g	Sept. 16	f	4	5
149	Red Seedling	1893	May 3	l	g	Aug. 30	f	2	2
150	Reid	1890	May 3	s	g	Aug. 27	f	6	8
151	Reeves (Fav.)	1890	May 4	s	g	Sept. 7	f	5¾	6
152	Ringold	1890	May 4	s	r	b.m.Oct.	c	6	9
153	River Bank	1892	May 2	l	g	July 24	s	3	2
154	Rivers	1888	May 2	l	r	Aug. 5	s	4	1
155	Roser	1892	May 2	l	r	m.e.Oct.	f	4	7
156	Roseville	1892	May 3	l	r	Sept. 20	c	4	10
157	R. S. Stevens	1891	May 3	s	r	Sept. 9	f	3	10
158	Salway	1890	May 3	s	r	Oct. 15	f	5	1
159	Scott	1890	May 3	s	r	Sept. 17	f	3½	1
160	Sener	1888	May 2	s	r	Sept. 14	f	6	10
161	Shipley	1890	May 2	s	g	Sept. 17	f	6	10
162	Smock free	1888	May 3	s	r	b.m.Oct.	f	5½	1
163	Smock X	1892	May 3	s	r	m.e.Oct.	f	4	6
164	Snow Late	1890	May 3	s	r	Sept. 3	f	3½	2
165	Southern Early	1890	May 3	s	r	Aug. 28	f	4	2

4

PEACHES.—Concluded.

Number.	Name.	Planted.	Bloomed.	Flowers—l, large; m, medium; s, small.	Glands—g, globose, r, reniform; s, serrate.	Ripened.	Adhesion—c, cling; f, free; s, semi cling.	Weight of fruit in ounces.	Productiveness—scale 1 to 10.
166	Spottswood	1892	May 4	l	r				
167	Stark Heath	1892	May 2	s	r	m.e. Oct.	c	6	6
168	Steadly	1888	May 2	s	r	b.m Oct.	f	4½	2
169	Stevens Late	1890	May 3	s	r	b.m. Oct.	f	4	1
170	Stevens Rareripe	1890	May 2	s	r	Sept. 19.	f	4½	2
171	St. John	1890	May 3	s	g	Aug. 19	f	3	1
172	Strong (Mammoth)	1892	May 2	s	g	Sept. 9.	f	5	2
173	Stump (the World)	1892	May 2	s	g	Aug. 14.	f	3	1
174	Summer Snow	1894			r				
175	Surpasse (Melocoton)	1890	May 3	s	r	Aug. 28.	f	4½	10
176	Switzerland	1890	May 3	s	g	Sept. 16.	f	4	4
177	Toledo	1894	May 2	l	g	Aug. 12.	f	2	
178	Toquin	1892	May 3	l	r	Sept. 9.	f	3	10
179	Townsend	1892	May 3	s	g	Sept. 24.	f	6	
180	Troth	1890	May 3	s	g	Aug. 26.	f	3½	3
181	Tuskena	1892	May 6		g				
182	Wager (Spurious)	1892	May 2	s	r	Sept. 27.	f	3	10
183	Walker	1892	May 2	s	g				
184	Walker var.	1893	May 3	s	g	Sept. 24.	f	5½	5
185	Washington	1890	May 3		g	Sept. 12.	f	3¾	5
186	Waterloo	1888	May 3	l	r	July 30.	s	3	1
187	Willett	1894	May 2	l	r				
188	Williamson	1892	May 2	s	g	Sept. 29.	f	4	
189	Wonderful	1890	May 3	s	r	b.m. Oct.	f	4½	2
190	Northern	1893	May 2	s	r	Aug. 30.	f	3	6
191	Yellow Rareripe	1888	May 2	s	g	Aug. 24.	f	2	1

The following notes are intended mainly to invite attention to new and promising varieties, to such older ones as appear to deserve increased attention, and to give such farther particulars as are supposed to be of more or less general interest.

Two varieties of peach have been received and planted here as Allen; also a third as Cleffey Allen, which appears in our lists as Cleffey (Allen), with the anticipation that the portion in brackets may be ultimately suppressed. Upon farther trial one of the former may prove to be identical with the last.

Alexander, Amsden, Canada, River Bank and Waterloo are all semi clings and for practical purposes may be treated as identical, though the last named is probably the best of the lot. A variety coming from Texas erroneously as Lady Ingold (which should be yellow), is also of this class.

Barber, a variety understood to have originated in Allegan county, Michigan, is also known as Hinman.

Bequette free and Bequette cling, as received from Texas, both prove to be free and identical.

Bickell, received from Delaware, ripens here in late October, quite too late for this latitude.

Bonanza may perhaps justify so pretentious a name in a more southern latitude. Here it is so late as to be worthless.

Brett is also too late, poor and small to be of any value here.

Brigdon is a fine yellow peach of good quality, a popular market variety in central New York. Garfield is probably identical with this.

Brunson, although coming to us from Delaware, is understood to be the variety of this name originated at Benton Harbor, Michigan.

Brown (Brown's Early) originated with the late W. A. Brown, of Berrien county, Michigan. It is an early, pale fleshed variety, an early bearer and productive. Ripe in August but less desirable than several others of its class and season

Champion originating in Illinois, but disseminated by an Ohio establishment, is a beautiful and excellent pale fleshed variety, an amateur peach, rather delicate for the rough handling of the markets. It ripens here the last of August. A serrate leafed Champion, originated in Allegan county, Michigan, is so liable to mildew of the young wood and foliage during summer, as to be of little value. This, however, may be prevented by persistent spraying with a solution of copper sulphate.

Chili 2 and Chili 3 are seedlings by C. Engle, of Paw Paw, Michigan, from the well known (Hill's) Chili. The two are much alike, ripening a little later than the parent, of slightly larger size and superior quality.

Crosby ripened a few specimens, late in September. It manifests good market qualities, but is apparently a somewhat tardy bearer.

Dunlap is a rather large, yellow peach of good quality, productive, ripening about September 1. It promises to be a superior market variety.

Early Crawford seedlings, 1 and 3, seedlings of C. Engle, are results of his quest for a variety similar to the original Early Crawford, but with hardier fruit buds. Experience with these so far indicates a possible improvement in this respect.

Early Michigan originated several years since near Lowell, Michigan, with J. D. Husted, then of that place, now of Georgia. His numbers 15, globose, and 16, reniform, are very much alike in fruit, so much so that they are grown and sold indiscriminately, by many nurserymen. Grown

here separately there are so far a few days difference in their time of ripening. Both are valuable.

Lewis, which is understood to have originated sometime since, in Allegan county, Michigan, closely resembles the foregoing, and by some persons the two are assumed to be identical. The fruits are scarcely distinguishable, although the Early Michigan appears to be slightly superior in quality.

Elberta, though originating at the south, is attracting much attention at the north. It has now fruited here two seasons, the fruit proving to be large and fine. Its productiveness here is yet to be determined.

Engle (Mam.), another seedling by C. Engle, has been disseminated to some extent as a promising market variety, ripening early in September.

Fox is a rather large and fine pale fleshed peach, of good quality, which is apparently worthy of a trial, to at least a limited extent.

Globe is large, beautiful and good, but so far unproductive. Ripe this season m. September.

Gold Drop (possibly an old variety renamed), ripe this season m. e. September; also Kalamazoo, ripe September 12, are both too well and generally known as popular market varieties to require description.

Haas (John), and Hynes (Surprise) are a few days later than the semi clings heretofore mentioned. They are freestones and for this reason desirable as early varieties for the home plantation.

Hale, Hale X No. 1 (a seedling by C. Engle), and Hyatt also, are all nearly alike in season and general character. All are semi clings.

Hance Smock, in season and general qualities, is quite similar to the old Smock free, slightly larger, though scarcely its equal in flavor.

Late Barnard is quite similar to Early Barnard in general qualities, but ripens two weeks later.

Late White (one of C. Engle's seedlings), although of only medium quality, is so far very productive, and for this reason may prove valuable as a late market peach.

Magdala, Nectarine, and Wales (Princess of), are fine amateur varieties of English origin. They are mainly desirable as fine flavored varieties for the home plantation.

McCollister, ripe September 24, is a large, attractive looking late yellow peach of good quality. It promises to be a regular and profuse bearer, worthy of extensive trial.

Moore (Fav.) is a pale fleshed peach of more than medium size, and of fine flavor. It is popular at the east.

Morris White has long been valued for the home plantation as a superior variety for canning.

Muir, in season m. September, is a fine yellow peach above medium size, of good flavor and productive. Promising for market.

Murat, a seedling by C. Engle, is a yellow peach of more than medium size, ripe e. September, and Pearl another from the same with pale flesh of superior flavor is ripe September 10. Both are worthy of trial.

Mystery (Yellow) is a very beautiful and excellent variety ripe September 24. So far it is comparatively unproductive.

Rivers (Early) ripe August 5 has scarcely an equal as an early peach for both dessert and market. It is of English origin.

R. S. Stevens is the name under which trees of a yellow variety were received from a western New York nurseryman for trial. They have now fruited two years but very sparingly. Not promising.

Salway is an excellent variety when well ripened but it is too late to be reliable in this climate.

Steadly ripe here b. m. October is apparently a tardy bearer and rather late for this latitude.

Stevens Rareripe proves so far to be a heavy bearer of fruit of medium weight and size and good quality. It promises to be profitable. Season m. e. September.

St. John is somewhat popular as an early yellow variety; ripe here August 19. Crane's Early is alleged to be a synonym but trees received under this latter name from Allegan county, Michigan, ripened fully three weeks later and are obviously distinct.

Wonderful of New Jersey is quite too late to be useful or valuable here. Its season in this locality is b. m. October.

Yellow Rareripe is an old variety and there appear to be a number of varieties doing duty under this name. A variety under this name some fifty years since was of fine size and high quality while the one grown here is of small size and low quality.

APRICOTS (*Armeniaca vulgaris*).

A few of the so called Russian Apricots were planted here in 1888 and still others in 1890. Several of these have shown bloom from time to time but have invariably failed to set and mature fruit. The trees also have most of them died from some not very obvious cause till only a few remain.

Two years since trees of the new Harris apricot (a recent New York seedling) were planted. These have grown finely and remain in apparently perfect health. Bloom may be expected upon them next season.

Some fifty years since the writer worked the Breda, and also the Black apricot upon plum stocks. These were planted and trained against the south side of a building, in which situation they bloomed and fruited freely for a series of years, until their removal became necessary to accommodate building improvements. Such experience seems to indicate that the failure of this fruit in this climate may be due to either innate lack of hardiness, or to its habit of very early blooming, one or both, and point to the need of a sheltered location.

Under the circumstances the Harris plants will be carefully watched with the hope that as a genuine American seedling it may prove the forerunner of a new and hardier strain.

They have been treated for insects and fungi in connection with peaches and plums, to which reference is therefore made.

NECTARINES (*Persica vulgaris*).

The nectarine, being closely affiliated with the peach, has been given a place in the peach plantation and subjected to the same general treatment, although owing to its special liability to the attacks of the curculio, only a single variety has thus far been planted.

For treatment as against insects and fungi, reference is made to the section on peaches.

Pitmaston Orange is the only named variety thus far planted. This is reputed to be a vigorous grower, but the plants which were received in 1892 prove to be persistently feeble, and so far have not even shown

bloom, a condition probably due either to disease or to the unfriendly influence of stock upon which it was worked.

GRAPES (*Vitis*).

The number of varieties of grapes now growing upon the Station premises is one hundred and sixty-seven.

Last spring proved unfortunate for the grape. The earlier part of May was rather mild, though with occasional paroxysms of cold, dangerously near the freezing point. Yet the young grape wood had made satisfactory growth and in most cases the incipient clusters were already formed, when after several threatenings a severe frost occurred during the night of May 21 and 22, killing nearly the entire new foliage and wood, and thus ruining the prospect of a season's crop of fruit.

The warm weather which followed, however, soon forced new growth from dormant buds, while more or less of the older buds upon the new canes proved to be so far uninjured that they finally burst into growth. It soon became obvious that so many young canes were being started that at least very many were likely to be too weak to become satisfactory fruiting canes for next season.

To at least partially escape this danger a large portion of the weaker canes was pruned away. The result being the increased growth of those remaining. Still it seems possible, if not even probable, that a still better result might have been secured by at once removing all the frosted young wood.

While this subsequent growth has produced a small crop of secondary clusters, which a very favorable summer and autumn has ripened fairly well, its amount will scarcely be claimed to have exceeded one-tenth, perchance not above one-twentieth of a full crop.

Aside from this the relative dates of ripening as well as the comparative productiveness are, as an unavoidable result, so seriously disarranged that any attempt to tabulate them seems likely to prove rather misleading than beneficial. This therefore is omitted for the present season.

PLUMS (*Prunus*).

The plums upon the station grounds both trees and fruit, have been notably exempt from the attacks of fungi during the year.

Among insects the curculio has been present as usual, also the rose chafer, the latter perhaps in somewhat reduced numbers. The cherry slug, though attacking the cherry, pear, and quince, has not been observed upon the plum this season.

The spray of copper sulphate applied while growth was yet dormant, included the plums. No subsequent applications were found to be needful.

On May 29 the crescent mark of the curculio beginning to appear upon the young fruits jarring was commenced, and was continued daily with only occasional intermissions, until June 29, when the insects had become so rare that it seemed no longer needful.

The same process was adopted against the rose chafer, its season being mainly coincident with that of the curculio, although more or less hand-picking was found to be necessary in the case of the chafer.

Plums bloomed from the 1st to the 6th of May, and the young fruits were therefore yet enclosed in the remains of the calyx during the frost of the 21st and 22d, which was probably the reason why they escaped the calamity which befell the grapes on that occasion.

The bloom of many varieties was very profuse, notably that of most of the Japanese varieties, some of which although hand-thinned while yet small, where still so borne down by the weight of the fruit when fully grown, that more or less of them were broken, although carefully supported.

Several of the more heavily laden trees were given a thorough drenching with water to enable them to carry through and properly mature their heavy burdens of fruit during the heat and unprecedented drouth then occurring. This was done by forming a trench about the tree, filling it with water and replacing the earth after the water had been absorbed. This process was repeated once or twice a week while the necessity continued.

PLUMS.

Number.	Name.	Species.	Planted.	Bloomed.	Ripened.	Weight of fruit in ounces.	Productiveness—scale 1 to 10.
1	Abundance	Hattan	1890	May 1	Aug. 9	1	
2	Agen Prune	Domestica	1890	May 4			
3	Archduke	Domestica	1893	May 3			
4	Arctic	Domestica	1891	May 3	Aug. 14	⅝	7
5	Bailey (S. S.)	Domestica	1890	May 2	Aug. 12	3	6
6	Baker prune	Domestica	1893	May 3			
7	Bavay	Domestica	1892	May 1	b. Oct.	1⅛	6
8	Black Diamond	Domestica	1892	May 1	Sept. 1	1¼	4
9	Black prune?	Domestica	1888	May 3			
10	Burbank	Hattan	1893	May 2	Aug. 26	2	10
11	Burbank 2	Hattan	1890	May 1	Aug. 9	1	1
12	Burbank 7	Mume?	1890	May 2	Aug. 22	1¾	8
13	Burbank 11	Hattan	1890	May 1	------	------	10
14	Chabot	Hattan	1893	May 3			
15	Cheney	Americana	1888	May 3	Aug. 15	1	5
16	Cook	Hortulana?	1890	May 4	Aug. 20	1	5
17	Czar	Domestica	1892	May 3	July 22	1	10
18	De Soto	Americana	1888	May 4	Aug. 25	1	10
19	Engle	Domestica	1890	May 2	Aug. 6	1	7
20	Englebert	Domestica	1890	May 3	Aug. 24	¾	9
21	Field	Domestica	1893	May 3	Aug. 16	1	10
22	Forest Garden	Americana	1889	May 4	Aug. 22	1	7
23	Forest Rose	Hortulana var. Mineri	1890	May 4	m. e. Sept.	1	10
24	Garfield	Hortulana	1889	May 6	m. e. Oct.	¾	10
25	Glass	Domestica	1890	May 3			
26	G. No. 4	Domestica	1890	May 3			[illegible]
27	Golden Beauty	Hortulana	1891	May 6	e. Oct.	¾	1
28	Grand Duke	Domestica	1890	May 3	Sept. 18	2	1
29	Gueii	Domestica	1890	May 3	Aug. 25	1	1
30	Hawkeye	Americana	1888	May 4	b. m. Sept.	1	9
31	Hungarian (Iowa)	Domestica	1888	May 3	Aug. 20	1	7
32	Jewell	Americana?	1890	May 4	Aug. 26	¾	6
33	Kelsey	Hattan	1890	May 2			
34	Kingston	Domestica	1890	May 2	Sept. 18	2	8
35	Lombard	Domestica	1890	May 3	Aug. 22	1	1
36	Long Fruit	Hattan	1890	May 3	July 18	¼	8
37	Maquoketa	Americana	1888	May 5	Sept. 16	1	9
38	Mariana	Cerasifera Hyb.?	1890	May 3	Aug. 10	1	6
39	Maru	Hattan	1890	May 1	Aug. 6	1	1
40	Merunka	Domestica	1888	May 3	July 31	1¼	7
41	Middleburg	Domestica	1890	May 3			
42	Miner	Hortulana var. Mineri	1890	May 4	Sept. 19	1	9
43	Moldavka	Domestica	1888	May 2	Aug. 14	------	8
44	Moreman	Hortulana	1890	May 6	July 26	⅜	8
45	Naples (Beauty of)	Domestica	1889	May 3	Aug. 25	¾	1
46	Newman	Angustifolia	1890	May 6			
47	Niagara	Domestica	1890	May 3	Aug. 25	¾	1
48	Nicholas (White)	Americana?	1890	May 3			
49	Ogon	Hattan	1890	May 3	July 24	⅜	1
50	Orel 20	Domestica	1888	May 4	Aug. 27	------	9
51	Pissard	Myrobalan?	1889	May 2			
52	Prairie (Flower)	Hortulana var. Mineri	1890	May 3	Oct. 1	1	9
53	Red Nagate	Hattan	1890	May 3	Aug. 9	1⅛	1
54	Robinson	Angustifolia	1890	May 6	Aug. 17	¾	1
55	Rollingstone	Americana	1888	May 4	Sept. 1	1⅛	8

PLUMS.—Concluded.

Number.	Name.	Species.	Planted.	Bloomed.	Ripened.	Weight of fruit in ounces.	Productiveness—scale 1 to 10.
56	Saratoga	Domestica	1890	May 3	Aug. 24	1½	1
57	Satsuma	Hattan	1890	May 3	Aug. 28	2	1
58	Shipper (Pride)	Domestica	1890	May 3	Aug. 19	2	10
59	Shiro Smomo	Hattan	1890	May 3	July 23	¾	1
60	Shropshire	Domestica	1890	May 4	Sept. 9	½	10
61	Simon	Simoni	1888	May 1	Aug. 25	2	1
62	Spanish (King)	Domestica	1890	May 3	Aug. 29	1	6
63	Van Buren	Americana var. Mollis	1890	May 4			7
64	Victoria	Domestica	1890	May 3	Aug. 16	1½	6
65	Wangenheim	Domestica	1890	May 4			
66	Weaver	Americana var. Mollis	1890	May 4	Sept. 25	1	4
67	Wolf	Americana var.	1888	May 4	Aug. 22	¾	10
68	Wyant	Americana	1890	May 4	Sept. 18	1	5
69	Yellow Aubert	Domestica	1888	May 3	Aug. 27	2¼	2
70	Yosebe	Hattan	1890	May 1	July 13	¾	9
71	Yosemite Purple	Americana	1892	May 4	Sept. 6	2-5	9
72	Yosemite Yellow	Americana	1892	May 4	Sept. 7	¾	9

NOTES RESPECTING SOME OF THE PLUMS FRUITED THE PAST SEASON.

European or domestica varieties.

Bailey is a variety received, in cion, from S. S. Bailey of Kent county, Michigan, without name, and is temporarily designated as above. The fruit is large, yellow, nearly free, and of excellent quality. The tree is vigorous, of upright habit. Productiveness yet undetermined.

Bavay was originally introduced from Belgium as Reine Claude de Bavay. But that type of high quality among plums, the true Green Gage or Reine Claude, having long since preempted both these names, their application to this is sure to occasion confusion. For this reason, and in the interest of brevity, the word Bavay (the originator's name) only is used to designate this variety.

Black Diamond, round, Grand Duke, long oval, and Kingston of similar form, and are each very large, with dense blue bloom and very showy. The trees are vigorous and productive.

Black prune (probably incorrect), Hungarian?, Merunka, Moldavka, Orel 20, and Yellow Aubert (received as Dame Albert), are all from Prof. Budd's Russian importations. Yellow Aubert promises to be the most valuable of these. So far nearly all are but moderately productive.

Czar has only fruited this year upon small trees. The fruit is large and attractive.

Engle, received without name, from C. Engle of Paw Paw, Michigan, is a rather small yellow plum of good quality. It is understood to be the originator's purpose to withhold it on account of its deficient size.

Gueii, Lombard, Naples and Niagara (as received here) are all very similar so far as their fruits are concerned, although the trees differ more or less in habit of growth.

Saratoga is promising as a market plum. Color purplish red, a rare color among the *domesticas*. Tree vigorous and productive.

Victoria fruited here for the first time this season. Weight of a specimen one and a half ounces, color red with yellowish grey dots, flesh firm, moderately juicy, nearly sweet, freestone. A market variety.

Native plums.

Few if any of these are desirable in Michigan, except possibly, in localities in which unusual hardiness is requisite.

Cheney, De Soto, Hawkeye, Moreman, Robinson and Rollingstone are among the most desirable of these so far as quality and reasonable productiveness are concerned.

Cook (Fav.), Forest Garden, Forest Rose, Nicholas (white), and Prairie Flower, have so far proved only moderately productive.

Garfield is very vigorous, very late and exceedingly unproductive. It is valueless here.

Golden Beauty is exceedingly vigorous and enormously productive. The clusters of fruit are very beautiful, but too late to acquire even tolerable flavor within our season.

Jewell, Maquoketa, Van Buren, Weaver, Wolf, Wyant, Yosemite Purple and Yosemite Yellow so far are neither sufficiently productive nor otherwise desirable for this region so far as tested here.

Oriental or Japanese plums.

Abundance is an objectionable name apparently chosen for purposes of trade. Its adoption can only be justified by the fact that it applies to one of the two varieties originally introduced to our country as Botan. In common with several other Oriental varieties, although of only medium size, and quality, it is so enormously productive that unless severely thinned, the tree will surely ruin itself by overbearing. Ripe b. August and continues a long time.

Burbank is similar to the foregoing in habit of growth, though more spreading, the fruit larger and of better quality, and ripening later. It promises to be productive.

Burbank 2 is much like Abundance, equally productive and ripens about the same time.

Burbank 11 is of finer flavor, larger size, and ripens later, but is less productive. In both tree and fruit it gives indications of a possible admixture of *domestica* blood.

Long Fruited. Trees received under this name are so far comparatively unproductive, the fruit small and round, ripening July 15. It is perhaps spurious.

Maru and Shiro Smomo are quite similar in most respects, though the latter differs in flavor and ripens a few days later. Both are enormously productive. Their fruit is similar to Abundance in general appearance.

Ogon has pale yellow fruit, slightly larger than the foregoing, but lower in quality. It is similarly productive and ripens about the same time.

Red Nagate is abundantly productive, and the fruit larger and of higher quality than is the case with most others of its class tested here. It ripens the last of August.

Satsuma is an oddity among plums. When fully ripe, both skin and pulp are very dark purple. Weight of fruits two ounces. This as well as most others of this class keep unusually well after ripening.

Yosebe is the earliest plum with which we are acquainted ripening here this season on July 13. Its size is rather small and quality only passable. So far it is a thin bearer.

Simon (quoted in catalogues as *Prunus Simoni*) is not recognized as belonging to either of the foregoing classes. The tree is a fine grower and very productive, and the fruit large and beautiful, but nearly or quite worthless, so far as quality is concerned.

Pissard (*Prunus Pissardi*) is only desirable as a novelty on account of the dark purple color of its foliage.

PEARS (*Pyrus communis*).

This second year of excessive drouth has proved even more severe than the preceding one, while even during the intervening dormant period the supply of moisture was by no means adequate. This deficiency must be supposed at least to some extent to have affected both wood and fruit growth. Quite possibly during both seasons it may have partially prevented the development of fruit buds and thus partially or wholly delayed the fruiting of some varieties. Be this as it may the trees have continued in a healthy and vigorous condition, and a considerable number of varieties have matured more or less fruit.

There have been no fungous attacks upon pear trees except in the case of two trees of Vicar in which the blight of last year compelled their entire removal last spring, together with one or two adjacent trees, the disease in which was not discovered until the planting season last spring.

The larvæ of the codling moth were so effectually subdued by the sprays applied to the first brood that a treatment for a second brood was deemed unnecessary, but too late it became obvious that either the remaining progeny of the first brood or an immigration from outside had sufficed to largely colonize the scattered product of the newly fruiting trees.

The slug (*Eriocampa cerasi*) appeared upon the pear at the usual season, but yielded readily to the usual spray of tobacco decoction.

The three or four trees which were supposed to have been overlooked in the preliminary spray of the spring of 1894, and which apparently for that reason were afflicted last season with scab (*Fusicladium dendriticum*) were together with the entire plantation thoroughly treated on April 1 to 6, with the strong copper sulphate solution with very satisfactory results.

On May 3 and 4 a second treatment was applied, using a solution of one pound of copper sulphate in 250 gallons of water.

May 20 a spray was applied consisting of four pounds of copper sulphate, nine pounds of lime and two and one-half ounces of Paris green in forty gallons of water.

June 1 the above was repeated as a remedy for the codling moth.

June 24 the slug having appeared they were treated with a strong dose of tobacco water which was thoroughly effective.

The following table includes such varieties of pears as have shown bloom and fruit, one or both, during the current year.

PEARS (*Pyrus communis*).

Number.	Name.	Planted.	Bloomed.	Ripened.	Weight of fruit in ounces.	Quality—scale 1 to 10.	Productiveness—scale 1 to 10.
1	Angouleme	1891	May 3	Oct.-Nov.	12	5	10
2	Anjou	1888	May 4	Oct -Nov.	5	4	9
3	Ansault	1889	May 4	b. m. Sept.	6	3	3
4	Barry	1892	May 5				
5	Bartlett	1891	May 5	b. m. Sept.	6½	5	9
6	Bessemianka (508)	1888	May 4				
7	Bloodgood	1888	May 3	Aug. 3	3½	3	6
8	Clairgeau	1891	May 4				
9	Clapp (Fav.)	1888	May 4	e Aug-b Sept	7	4	3
10	Comice (Doyenne du)	1891	May 4	Oct.-Nov.	4	2	3
11	Congres (Souv.)	1890	May 5				
12	Dana Hovey	1888	May 4	Nov.	4	1	[illegible]
13	Duhamel	1891	May 4	b. Sept.	7	2.3	
14	Early Duchesse	1892	May 5				
15	Fitzwater	1891	May 5				
16	Gakovsk (347)	1888	May 4	b. Aug.	3	7	10
17	Giffard	1888	May 4	b. Aug.	4	2	7
18	Gray Doyenne	1888	May 4	m. Nov.	4	4	4
19	Howell	1888	May 4	m. e. Sept.	7	3.4	4
20	Jones	1889	May 4	e. Oct.	4	2.3	9
21	Kurskaya (392)	1888	May 3	m. e. Sept.	4	7.5	8
22	Lawrence	1888	May 3	Nov.-Dec.	5	2.3	7
23	Louise (Jersey)	1891	May 4				
24	Lucrative	1888	May 4	b. m. Sept.	5½	2	1
25	Margaret	1889	May 4	July 25	2	4	4
26	Millett	1891	May 5				
27	Mount Vernon	1891	May 4	----------	8		
28	Ogereau	1891	May 4	Oct.-Dec.	11	4.5	
29	Pitmaston	1891	May 5				
30	Pound	1889	May 4	Winter	12	10	10
31	Reeder	1891	May 4	m. Oct.	7	2.3	1
32	Rostiezer	1888	May 4	Aug. 13	3	1	6
33	Rutter	1892	May 4				
34	Seckel	1888	May 4	----------	----	----	6
35	Summer Doyenne	1888	May 4	July 18	1	5	8
36	Victorina	1888	May 3	Aug. 13	4½	8.9	7
37	Winter Nelis	1888	May 5	Oct.-Dec.	7½	1	4

Angouleme (usually known as Duchess) is reputed to be only desirable as a dwarf, for which purpose it is doubtless one of the best. It may however, be doubtful whether this assumption is not due quite as much to the preference of nurserymen for this method of propagation as to any actual advantage of dwarfs over trees grown upon free stocks. The experience of the writer both at this Station and elsewhere is quite in favor of the latter.

Anjou, though reputed to be a tardy bearer, has this year produced a few good specimens upon trees planted as yearlings in 1888, branched low and managed as dwarf standards.

Ansault (Bonne de Puits Ansault) is an early bearing, very prolific variety and the fruit of fine size, though of only moderate quality.

Bloodgood, an old variety, is an early and profuse bearer, fruit of good size and finely flavored, ripening early in August.

Clapp (Favorite) ripened in advance of Bartlett. It is large, beautiful and good, but must be picked early to prevent rotting at the core.

Dana Hovey is small but excellent, and the tree very satisfactory. It is one of the very finest early winter pears for the home plantation.

Comice (Doyenne du Comice) is a large and excellent pear, which was received and planted in 1891, as Howell, to which it is far superior in both size and quality.

Gakovsk, Kurskaya, Bessemianka and Victorina are from Prof. Budd's importations from eastern Europe. None of them compare favorably with our well known varieties of similar season.

Giffard, an early August pear of high quality, is admirably adapted for use in the plantations of critical lovers of this fruit.

Gray Doyenne is an old and excellent amateur pear, ripening in October and November. It is now rarely planted.

Howell is well known as a desirable market pear for late September.

Jones is a scarcely medium sized pear of very good quality, ripening in October and November.

Lawrence has many desirable qualities of both tree and fruit, which render it desirable as an early winter market variety.

Lucrative is an old and excellent pear, which every lover of this fruit should plant for home use. With better color it would doubtless be valued as a market fruit also.

Margaret. Several varieties have been received and fruited under this name. Farther trial is needful to determine the identity of each. A small very early one is of fair quality and very productive.

Mount Vernon. Two varieties have been received and fruited under this name, and farther trial is needful to properly determine their identity.

Ogereau, a large pear, season November and December, is a vigorous grower and an early bearer. Worthy of trial for market.

Pound is a very old variety, very large, but only valuable for show and for the kitchen.

Reeder (Doctor Reeder) is a fruit weighing seven ounces, of high quality, keeping through November.

The tree is thrifty and so far an early and abundant bearer.

Rostiezer is an old European variety, weighing only three ounces and not of attractive appearance, but of exquisite flavor. Season August. Tree vigorous, very spreading, requires severe cutting back to produce a satisfactory head.

Seckel is well known for its exquisite flavor. Its diminutive size is its chief drawback, which, however, is compensated by its productiveness. The tree is healthy and remarkably free from blight.

Summer Doyenne (Doyenne d'Ete.) is the earliest reasonably good pear. Although of diminutive size, this is compensated by its productiveness. The tree is vigorous and healthy.

Winter Nelis ranks among winter pears as does the Seckel among the summer and autumn varieties, as the type of high quality. The tree is of a straggling, irregular habit and doubtless for that reason is not popular with nurserymen, who usually double work it.

APPLES (*Pyrus malus*).

Apples, in common with other fruit trees, have made satisfactory growths, notwithstanding the prevailing drouth, and a very considerable number of varieties have shown more or less fruit.

Whether due to the spray applied April 1 to 6, or otherwise, no fungi have been discovered attacking either trees or fruit during the season,

and the only insect noted was the second brood of codling moth larvæ, the appearance of which had not been anticipated since the first brood had been conspicuous by their absence.

Following the general spray of April 1 to 6:

On May 3 to 4 apples were sprayed to prevent scab, with a solution of one pound of copper sulphate in 250 gallons of water.

On May 20 they were again sprayed, this time with Bordeaux mixture consisting of four pounds of copper sulphate, nine pounds of stone lime and two and one-fourth ounces of Paris green in forty gallons of water.

On June 1 the spray was repeated using the same mixture.

Farther treatment should doubtless have been applied to destroy the second brood of codling moth larvæ, but the apparently thorough destruction of the early brood had left the conviction that no second brood need be expected, and this error was not discovered till too late for remedy.

The following table includes the varieties which have bloomed and fruited, one or both, during the current season.

Under the head of productiveness the results of the current year only are given.

The word crab attached to a name is not to be understood as any part of such name.

In grading as to quality crabs are compared with crabs only.

APPLES (*Pyrus malus*).

Number.	Name.	Planted.	Bloomed.	Ripened.	Weight of fruit in ounces.	Quality—scale 1 to 10.	Productiveness—scale 1 to 10.
1	August (crab)	1890	May 5				
2	Babbitt	1890	May 5		6	5.6	7
3	Barry	1888	May 9		8½	3.4	9
4	Batullen	1888	May 6				
5	Blue Anis	1890	May 6	Sept. 15	5½	4.5	10
6	Borovinka	1888	May 14	Aug. 7	8	5	3
7	Bough	1888	May 16	Aug. 13	6½	3.4	8
8	Bradford	1890	May 6				
9	Carlough	1889	May 8				
10	Chenango	1888	May 7	Aug. 13	6	3	10
11	Cogswell	1888	May 6				
12	Colton	1888	May 4	July 22	6	4	7
13	Cornell	1890	May 5	b. Sept.	6	3.4	2
14	Craine	1888	May 7				
15	Cullin	1890	May 6				
16	Dartmouth (crab)	1890	May 5	Sept. 1	2	1	2
17	Dickinson	1889	May 7				
18	Dyer	1888	May 6				
19	Early Strawberry	1888	May 7				
20	Egyptian	1888	May 8				
21	Excelsior (crab)	1890	May 5	Aug. 24	6	4	7
22	Fall Pippin	1888	May 7				
23	Fink	1892	May 7				
24	Florence (crab)	1890	May 4	Aug. 10	1½	5.6	1
25	Flushing	1888	May 8				
26	Gano	1890	May 6	Sept. 16	10½	5	7
27	Garden Royal	1888	May 8				
28	Gibb (crab)	1892	May 4	Aug. 15	2½	2	5
29	Gideon	1890	May 5	Sept. 1	6½	5	7
30	Gloege	1888	May 6				
31	Golden Reinette	1888	May 5				
32	Golden Russet (N. Y.)	1888	May 5	Dec.-Mar.	5½	3	7
33	Grimes	1890	May 5	Dec.-Mar.	6	2.3	7
34	Grosh	1890	May 6				
35	Hagenkopt	1888	May 7				
36	Hargrove	1892	May 6				
37	Hawley	1888	May 6				
38	Hubbardston	1888	May 7				
39	Indian	1892	May 10				
40	Iowa Keeper	1891	May 6				
41	Jefferis	1888	May 5	b. Sept.	7½	2	6
42	Jelly (crab)	1890	May 5	b. m. Sept.	2	5	5
43	Jersey Sweet	1888	May 5	b. Sept.	6	2	4
44	Jonathan	1888	May 6	Nov.-Mar.	5	3	6
45	Keswick	1888	May 5	Aug.-Sept.	6	6	1
46	Lawver	1890	May 7	Jan.-May	7	6.7	6
47	Longfield	1892	May 5	Sept. 14	7	5	8
48	Lou (crab)	1890	May 5	Aug. 6	6½	5	9
49	Lowell	1888	May 6	Aug. 19	10	3.4	2
50	Magog	1890	May 7		6		
51	Maiden Blush	1888	May 5				
52	Marmalade	1888	May 8				
53	Martha (crab)	1890	May 6	b. Sept.	2¾	1.2	3
54	Mason Orange	1890	May 9	Nov.	8	5.6	10
55	Minkler	1892	May 5	Jan.-Mar.	9	6.8	10

APPLES.—Concluded.

Number.	Name.	Planted.	Bloomed.	Ripened.	Weight of fruit in ounces.	Quality—scale 1 to 10.	Productiveness—scale 1 to 10.
56	Nero	1890	May 5				
57	Northfield	1890	May 5				
58	No. 2 New	1890	May 7	Aug. 31	8	4	8
59	Oakland	1888	May 5	Nov.-Mar.	5½	4	10
60	October	1890	May 5	Sept.-Oct.	5	3.5	5
61	Ontario	1890	May 6	Jan.-April	9	3.5	7
62	Peck (Pleasant)	1888	May 8				
63	Peter	1890	May 5	b. Sept.	10	3.4	3
64	Pickett	1888	May 8				
65	Pine Stump	1892	May 6				
66	Primate	1888	May 5	July 20	8	2	3
67	Pryor Red Seedling	1888	May 8				
68	Pyrus malus, rosea plena	1892	May 8				
69	Quaker	1891	May 6				
70	Rambo	1888	May 9				
71	Red Aport	1888	May 7	b. m. Sept.	11½	5	7
72	Red Astrachan	1888	May 5	Aug. 1	6½	4.6	5
73	Red Canada	1888	May 6	Jan.-May	6	2.3	8
74	Red Dettmer	1888	May 5	b. Sept.	7½	5	7
75	Red Russet	1890	May 10				
76	Reid Golden	1890	May 6	Aug. 9	5	5	7
77	Rhode Island	1888	May 6	Nov.-Feb.	10½	2.3	10
78	Rosenhager	1888	May 8	m. e. Sept.	12	4.5	10
79	Roxbury	1888	May 6	Jan.-June	6	3.4	8
80	Salome	1888	May 9				
81	Scarlet Cranberry	1891	May 6				
82	Shackleford	1893	May 9				
83	Sheriff	1891	May 6				
84	Smokehouse	1893	May 7				
85	Somerset (N. Y.)	1893	May 7	Aug. 19	3½	3	10
86	Stark	1888	May 6	Jan.-May	8	7.8	2
87	Stuart	1890	May 7				
88	Stump (N. Y.)	1889	May 7				
89	Summer Pearmain	1888	May 5	b. Sept.	5½	1	8
90	Summer Rose	1892	May 5	Aug. 12	4	2	10
91	Thornton	1892	May 6				
92	Titovka	1888	May 5	Aug. 5	9	4.6	4
93	Tolman	1888	May 7	Nov.-April	6	3.4	9
94	Townsend	1890	May 7				
95	Transcendent (Crab)	1893	May 6	Aug. 21	2	5	7
96	Washington (Strawberry)	1890	May 5	Sept.-Oct.	9½	------	10
97	Water	1890	May 6	Oct.-Nov.	6	5	9
98	Wealthy	1890	May 6	Sept.	------	------	5
99	Winter Streifling	1888	May 5	Aug. 20	5	5	3
100	Yellow Transparent	1888	May 6	July 22	5	7	5
101	Zolotoreff	1890	May 5				

It should be understood that the fruit trees at this Station are yet young, many of the apple trees bearing their first crop of fruit this year, and that for this reason the results noted may be modified as they come more fully into bearing.

Babbitt comes to us from Missouri. Little can yet be said respecting it from actual experience here. If valuable here it will probably be on account of color or productiveness rather than for superior quality.

Barty is a sweet apple whose first specimens here weigh eight and one-half ounces. In quality it grades 3 to 4, one being the highest. Should it prove productive it may rank as a desirable market variety.

Blue Anis, Longfield, Red Dettmer, Rosenhager, Titovka and Winter Streifling are all of reputed Russian origin. Nearly all are of the J. L. Budd importation, very subject to blight in the northwest, and most of them ripening in winter only at the extreme north. So far they have been free from blight here, but nearly all ripen in August and early September.

Borovinka is also one of the Budd importations. If not identical with Oldenburg it so closely resembles it in both tree and fruit that it is difficult to distinguish the one from the other.

Bough, generally known as Sweet Bough, is our earliest good sweet apple. Its chief fault is that it is a thin bearer.

Chenango is well and favorably known as one of the numerous group of strawberry apples. When well grown it has few superiors as a dessert or family apple. It is also esteemed for a near market.

Colton is a comparatively new variety. Here so far it proves to be an early and prolific bearer, specimens weighing six ounces and ripening the latter half of July; quality 4, of the scale 1 to 10. Desirable for both home use and market.

Cornell originated in Pennsylvania, and is successful in Michigan. Its most serious fault is ripening in early September, when even the best apples are at a discount, as compared with the more delicate peach and plum.

Dartmouth, Excelsior, Florence, Gibb, Jelly, Lou, Martha, No. 2, New and Transcendent are all crabs of the *Pyrus baccata* type, ripening in August and early September, varying more or less in quality, but all possessing the distinctive flavor of the species.

Gano has ripened its first crop of fruit here this season. The specimens are beautifully colored, weighing ten and one-half ounces, and ripening September 16. It will rank as a market fruit if sufficiently productive.

Gideon, October and Peter are all seedlings by Peter M. Gideon, of Minnesota, as is also the Wealthy. All are very hardy and adapted to the extreme northern climate. They are claimed to be partially or wholly of crab parentage.

Golden Russet (N. Y.) is too well known to require either description or characterization. It lacks size, unless with good and rich cultivation, and must be kept in tight packages to prevent shriveling.

Grimes (Golden) is reputed to have originated in Virginia. It is one of the very few varieties which maintain their quality when grown at the north.

Jefferis is a native of Pennsylvania. It has few if any superiors as a beautiful and excellent dessert fruit, for late August and early September. Specimens grown here this year weighed seven and one-half ounces.

Jersey Sweet is perhaps the very best sweet dessert and baking apple for early September.

Jonathan is generally popular as a beautiful and excellent mid-winter apple, for either dessert or market. Its chief defect for the market is lack of size, well grown specimens weighing scarcely more than five ounces.

Keswick (Codlin) is one of the very best and most productive culinary apples, too acid for other uses, it cooks well even when half grown.

Lawver is a long keeper, of supposed western origin, of mild subacid flavor, ranking as low as 6 or 7 in the scale of 1 to 10. Tree vigorous and hardy.

Lowell is an old variety, ripe in early September. It is of fine appearance and very productive. Weight ten ounces. It is doubtless less popular on account of the wealth of the more delicate fruits contemporaneous with it.

Magog (Red Streak) is a western variety valued especially for its hardiness. It is not yet sufficiently tested here.

Mason Orange received from Kansas, ripe here November to probably January or February, weight eight ounces, is a roundish or slightly oblate, irregular fruit, yellow, with a faint brownish blush, flavor mild subacid, tree vigorous, spreading, needs farther trial here.

Minkler is an old variety, grown mostly at the west, season January to March, weight nine ounces, quality low, 6 to 8, tree vigorous, spreading.

Oakland is known in some localities as Oakland Co. Seeknofu rther. It ripens here in September but is said to be a winter keeper. Weight five and one-half ounces, color yellow, blushed and striped with two shades of red. Flavor mild subacid. Quality 3 to 4. Growth of tree slender, spreading.

Ontario, originated by the late Charles Arnold, of Paris, Ontario, is a cross between Northern Spy and Wagener. The fruit is in season from January to April. Weight nine ounces. Color pale yellow with a bright red cheek, flesh tender, juicy sub-acid. Quality 3 to 5. Tree vigorous, upright, spreading, an early bearer.

Primate is well and favorably known as one of the very best summer dessert apples,' ripening in succession through a considerable period. The fruits when large are sometimes water-cored.

Red Aport is one of Prof. Budd's Russian importations. Its weight is eleven and one-half ounces, season b. m. September. In form, color and quality it is much like the well known Alexander.

Red Astrachan is too well known as a leading summer market and culinary apple to require description. It ripened here this season August 1, weight six and one-half ounces.

Red Canada is the apple so long and favorably known in the markets of Detroit and Chicago as Steele's Red. In some soils and localities it is inclined to scab and crack. It is a slender grower and should always be top grafted on vigorous stocks. Season January to May, weight six ounces.

Reid Golden comes to us from New Jersey, without a history. It ripens here August 9, weight five ounces; form oblate, color dark, rich red, on a yellow ground, flesh white with red stains next the skin, quality 5. A culinary fruit.

Rhode Island Greening is universally prized at the north and east, as a leading winter apple; in season here from November to February or

March; weight ten and one-half ounces. Farther south it becomes an autumn fruit.

Roxbury Russet, long known and prized as a superior, long keeping, culinary market apple, in season from January to June; weight six ounces. It is open to the objection that the tree lacks hardiness at the west.

Somerset (N. Y.) ripened August 19, weighing three and one-half ounces. The fruit is conical and not attractive in appearance, but sprightly, high flavored and rich. Quality 2. Tree an upright grower and an early bearer.

Stark hails from Ohio. It is a long keeping, winter apple. Weight eight ounces. Quality as low as 7 or 8. Tree very vigorous, hardy and productive. A market apple.

Summer Pearmain is a beautiful and excellent fruit for the home plantation, ripe early in September. Weight five ounces. Unfortunately the fruit is liable to scab and crack. The tree is hardy, but of scarcely medium vigor. It requires good-rich culture.

Summer Rose is a beautiful and excellent little fruit for the home garden. Ripe early in August. Weight four ounces. Quality 2. The tree is moderately vigorous and very productive.

Tolman is a long keeping winter sweet apple, weight four ounces. Tree very hardy. Generally popular.

Washington (Strawberry), ripe in September and October. Weight nine and a half ounces. Is a roundish oblate, yellow apple, splashed and mottled with rich red; flesh a little coarse, tender, juicy, brisk sub-acid. Culinary, market.

Water, ripe October and November, weight six ounces; quality 5; is a culinary variety; so far only moderately productive.

Yellow Transparent is reported to be of Russian origin. Ripe July 22, weight five ounces. The fruits are usually free from imperfection and even sized; color pale yellow, flesh a little coarse, white, tender, juicy, acid; culinary. Tree vigorous, upright, very productive.

QUINCES (*Cydonia*).

No indications of fungi have been observed during the past season.

The only insect attacks demanding attention have been those of the slug (*Eriocampa cerasi*) to subdue which a single spray of strong tobacco water proved sufficient.

Quinces have fruited much less freely than usual the past season, due apparently to the frost of the morning of May 21, at which time the plants were in bloom.

Quality being a somewhat variable characteristic, dependent upon peculiarity of the season, and the more or less perfect development of the fruit, the grading given in the following table will be liable to modification in other and more favorable seasons.

QUINCES (*Cydonia*).

Number.	Name.	Planted.	Bloomed.	Ripened.	Weight of fruit in ounces.	Quality, scale 1 to 10.	Productiveness, scale 1 to 10.
1	Alaska	1891	May 11	b. m. Oct.	5½	1	8
2	Champion	1888	May 16	m. e. Oct.	9	1	2
3	Fuller	1891	May 18				
4	Meech	1888	May 15	b. m. Oct.	7½	1	6
5	Missouri (Mam.)	1890	May 10	b. m. Oct.	9	1	7
6	Orange	1888	May 10	e. Sept.	12½	1	4
7	Rea	1885	May 10	e.Sep., b.Oct	9½	1	7
8	Van Deman	1895	May 18				

Alaska, as the name may be supposed to indicate, is alleged to be especially hardy. As yet it is but imperfectly tested here.

Champion is an early and prolific bearer, but ripens rather late for this latitude, especially in unfavorable seasons.

Meech so far has in no sense shown itself superior to older, well known varieties.

Missouri (Mam.) as tested here, differ but slightly, if at all, from the old well known Orange quince, which still is without an equal, everything considered.

NUTS.

Almonds (*Amygdalus communis*) are represented here by Luelling, a hard shell variety, and also by one received as Soft Shell, neither of which has yet shown fruit.

Chestnuts (*Castanea*). Hathaway bloomed July 12 and Ridgley and Numbo each produced catkins, but neither of them produced fruit.

Paragon has produced a heavy crop of nuts, which were smaller than usual, probably by reason of the severe drouth. It bloomed July 1 and ripened in advance of frost.

Spanish chestnut also bloomed and ripened at the above dates.

Kentish Cob Filbert has produced catkins the past two years, but has not yet shown fruit.

Japan Walnut (*Juglans Seiboldii*), bloomed July 11, but the young germs were badly injured by frost so that only a very few survived, which matured and dropped with the first kiling frost.

ASPARAGUS (*Asparagus officinalis*).

Three varieties of asparagus, Barr, Conover and Palmetto, have been on trial since 1890, of which Palmetto has been found the most desirable. A more recent variety, the Columbian Mammoth White, of which seed was planted in 1894, is promising, but requires another year or two for a complete test.

RHUBARB (*Rheum raponticum*).

In out of door culture none of the so called early varieties tested here have proved perceptibly earlier than Linnæus, which still maintains a leading position.

A new variety received two years since from S. S. Bailey, of Kent county, is of large size and excellent quality, with distinct dark green foliage. It is worthy of extensive trial

EXPERIMENTS WITH FERTILIZERS.

Quantities of several commercial fertilizers having been supplied, the five rows of grapes in the northeast block, planted in 1888, and trained upon a four wire, horizontal trellis, fifty plants in each row, were divided into sections, each extending across the entire five rows, and applications of fertilizers made as follows: The growth of plants in the sections not fertilized is assumed to be medium, or 5, in the scale 1 to 10, 1 being the maximum. The crop of fruit being exceedingly light owing to a killing frost in May last, is not taken into the account.

Section.	No. of plants.	Fertilizers applied.	Rate of growth.
1	10	None	5
2	20	Ground bone, 15 lbs.; muriate of potash, 7 lbs.	4
3	20	None	5
4	20	Michigan Carbon Works fruit grower, 25 lbs.	3
5	10	None	5
6	20	Ground bone, 15 lbs.; muriate of potash, 7 lbs.; nitrate of soda, 3 lbs.	3
7	10	None	5
8	20	Two one-horse loads stable manure	2
9	10	None	5
10	20	Ground bone, 15 lbs.; muriate of potash, 7 lbs.	2
11	10	None	5
12	20	Michigan Carbon Works fruit grower, 25 lbs.	2
13	20	None	5
14	20	Ground bone, 15 lbs ; muriate of potash, 7 lbs.; nitrate of soda, 3 lbs.	3
15	10	None	5
16	10	Mich. Carbon Works fruit grower, 9½ lbs.; ground bone, 5 lbs.; muriate of potash, 5 lbs.	2

SOUTH HAVEN, MICH.,
January 1, 1896.

T. T. LYON.

FRUITS AT THE AGRICULTURAL COLLEGE.

L. R. TAFT AND H. P. GLADDEN.

STRAWBERRIES.

The soil upon which the strawberries were grown is a sandy loam in which is considerable clay. Some portions have much more clay than other parts of the field. Under much the larger portion, at a depth of from one and a half to two feet, is a heavy clay subsoil. Some parts of the field rest upon quicksand which often comes within a few feet of the surface. A good application of stable manure was given and the land plowed the fall before the plants were set. The summer of 1894 was unfavorable for the plants to make a good growth for the fruiting season of 1895. The frequent rains occurring in the early part of year gave the plants a good start, but the protracted drouth of summer and fall prevented the formation of runners and in many cases killed the plants first set. The field was cultivated frequently during the season and was free from weeds. After freezing weather came on the plants were quite heavily mulched with marsh hay. In the spring this was removed from above the plants and placed between the rows. This mulch was utilized to cover the plants when frost was expected. For several days, after the blossoms had appeared, the plants were covered with the mulch and protected from frosts. This was removed when danger was thought to be passed. An unexpected freeze came when many sorts were in full bloom and the blossoms of many varieties were almost entirely killed. A system of pipes for irrigating purposes was put in last spring, but was not in shape to put on the water until June 10. This prevented an early application which would have greatly benefited the spring set plants; however, we have a fair stand of most varieties for the season of 1896. One watering was given the field when the berries were well formed and another when they were just ripening. This enabled those varieties which had made a fair stand of plants and whose blossoms escaped frost to mature a good crop of fruit.

In the following table many varieties which have in other seasons proved valuable are omitted because of the effects of the drouth of the previous year and of the frosts of 1895.

STRAWBERRIES.

ABBREVIATIONS.

Form.
b, broad. l, long.
c, conical. o, oval.
d, depressed. r, round.
i, irregular.

Size.
s, small.
m, medium.
l, large.

Color.
b, bright. l, light.
c, crimson. r, red.
d, dark. s, scarlet.

Variety.	Sex.	Vigor (1-10).	Date of bloom.	First ripe fruits.	Last fruits.	Productiveness (1-10).	Size.	Form.	Color.	Quality.	Firmness.
Afton	p	8.5	May 14	June 12	July 3.	9	m to l	l c	d c	9	8.8
Allen No. 1	p	9.5	May 14	June 12	June 27.	5	m	r c	b c	9	8.5
Allen No. 3	b	9	May 16	June 17	July 3.	7	l	r c	b c	9	8.5
Allen No. 13	p	8	May 14	June 12	June 28.	7	m to l	r d c	v d c	9	9
Allen No. 14	p	7	May 16	June 13	June 28.	5	m	l c	l s	9	7.5
America	b	8.5	May 14	June 17	July 3.	8	m	r c	b d s	9.5	9
Aroma	b	9	May 18	June 13	July 4.	8	l	l c	l s	8	9.5
Beauty	b	8	May 16	June 6	June 29.	8	l	r b c	b d s	8.5	8
Belle	b	8	May 16	June 16	July 5.	9	m to l	l c	b s	8	9
Belle of Lacrosse	p	8.8	May 14	June 12	July 2.	9	l	r b c	b d s	8	8
Bickle	p	8	May 18	June 16	July 6.	7	m	r c	l s	7	7
Bird	p	8.5	May 16	June 16	July 2.	9.2	l	l c	b d s	9	9.2
Bixler Seedling	b	9.5	May 14	June 17	July 3.	5	s to m	r d c	l s	9.5	8.5
Bomba	b	7.5	May 14	June 14	July 1.	9	m	c	d c	9	8.5
Brandywine	b	8	May 12	June 17	July 3.	7	l	r c	b d c	9.5	8.5
Bubach	p	8	May 14	June 17	July 2.	8	l	d c	l c	9	8
Cameronian	b	9	May 14	June 13	July 3.	7	m	r c	l s	7	7
Cameron No. 2	b	8.5	May 16	June 13	July 2.	7	l	l c	b c	9	9
Charlie	p	8	May 18	June 12	June 28.	6	m	l c	b d s	9	8.8
Childs	b	7.5	May 16	June 13	July 7.	7	l	d c	b c	9.5	9
Cyclone	b	9.8	May 10	June 14	July 4.	9	m	l c	d c	9	9
Dan Bisel	b	7.5	May 14	June 12	June 28.	8	m	l b c	b c	9	9
Early Jack	b	8	May 10	June 7	July 4.	5	m	r c	l s	6	6
Edith	p	6	May 18	June 17	July 5.	----	m	r c	r d c	9.5	9
Edwards Favorite	b	7	May 16	June 13	July 8.	8	l	r c	b d c	9.4	9
Epping	p	9	May 14	June 12	July 2.	8	l	r d c	l s	8	9
Feicht No. 3	p	8	May 10	June 7	July 2.	7	l	i c	l c	8.8	8
Fred Stahelin	p	8.5	May 14	June 8	June 27.	8.5	l	i c	v d c	9.5	8
Greenville	p	8	May 16	June 12	July 3.	6	l	r d c	b c	8	7
Haverland	p	8.5	May 10	June 8	June 28.	8	m	l c	s	8	8
Jay Gould	p	9	May 16	June 12	July 4.	8.5	m	r c	b c	9.2	9
Jones Seedling	b	8	May 10	June 6	July 3.	7	l	d c	d c	9	8.5
Judsonia	b	9.5	May 10	June 13	July 1.	8	l	r b c	l c	7.5	7
Klickita	p	9.5	May 14	June 15	July 3.	8.5	l	r d c	d s	9	7.5
Kyle No. 1	b	9	May 18	June 17	July 2.	----	m	r c	l s	6	6
Leroy	p	9.5	May 10	June 12	June 28.	8.5	l	d c	d c	9	9
Longfield	p	8	May 10	June 12	July 3.	8.5	l	r c	d c	9.2	9.4
Long John	b	8.5	May 18	June 7	July 3.	9.8	m to l	v l c	b c	9	8.5
Magnate	p	8.5	May 10	June 13	July 3.	8	m to l	l c	b s	9	9
Marshall	b	8.5	May 10	June 17	July 5.	----	l	r c	b c	8.5	9
Maxwell	p b	9	May 10	June 14	June 28.	8.8	m	r c	d c	9.8	8.5
Miner	b	8.5	May 10	June 14	July 2.	7.5	l	c	d s	8	7
Mrs. Cleveland	p	9	May 12	June 18	July 3.	8	m	r b c	b s	8	8
Neptune	p	8.5	May 18	June 16	July 2.	8.5	m to l	r c	d c	7	7
Nims' Seedling	p	9	May 16	June 17	July 6.	8.8	l	r c	b s	9.2	7.5
No. 16 (Stayman & Black)	b	8.5	May 14	June 14	July 2.	----	l	r c	d s	8	8.5
No. 6 (J. S.)	p	8.5	May 14	June 13	July 5.	8	l	r c	d c	9.8	9
No Name	b	9.5	May 10	June 17	July 3.	9	l	b c	d c	9	9
Parker Earle	b	9	May 20	June 19	July 6.	9.5	m	l c	d s	8	9
Phillip Seedling	b	8.5	May 10	June 14	July 2.	----	l	r c	d c	7	7

STRAWBERRIES.—CONCLUDED.

Variety.	Sex.	Vigor (1-10).	Date of bloom.	First ripe fruits.	Last fruits.	Productiveness (1-10).	Size.	Form.	Color.	Quality.	Firmness.
Princeton Chief	p	9	May 10	June 13	June 28	8	l	l c	d c	8.5	8.8
Princess	p	9.5	May 16	June 13	July 2	8	m	r	s	9	8.5
Rio	b	8.5	May 10	June 14	July 3	....	m	l c	b s	9	7.5
Robinson	b	9	May 16	June 17	July 5	...	m	r c	b c	6	6
Sadie	p	9	May 12	June 7	June 28	9	m	r c	d c	9	8
Shawnee	p	7	May 18	June 17	July 3	....	m	l c	d c	8.5	8
Shuckless	b	8.5	May 14	June 14	June 28	....	l	r c	d c	7	7
Smith Seedling	b	8	May 12	June 1	June 20	....	s	r c	b s	8	8
Snowball	b	9.5	May 16	June 14	July 6	...	m to l	l c	b s	8	9
Springdale	b	9	May 16	June 16	July 10	9.5	l	r c or l c	b s	8	9
Stimmel No. 20	p	9	May 12	June 14	July 3	7	s to m	l c	d c	9	8
Surprise	b	9.2	May 10	June 14	July 2	7	l	l c	b s	8	8.5
Swindle	p	9.4	May 16	June 14	July 5	8	m to l	r c	c	7	9
Tennessee Prolific	b	6	May 16	June 19	July 6	....	l	r c	b d c	8	8.5
Timbrell	p	8	May 18	June 17	July 6	....	l	v c	v d c	8.5	8
Thompson No. 34	p	...	May 18	June 14	July 3	8.5	m	r c	b c	8	8
Thompson No. 40	p	9	May 10	June 14	July 6	9.5	m	r c	b c	8.5	8
Thompson No. 64	b	8.5	May 16	June 14	July 5	8	m to l	i r c	b d s	8.5	9
Thompson No. 66	p	8.8	May 14	June 14	July 2	9	l	l c	b d c	8	8
Tonga	p	8.5	May 14	June 14	July 6	....	m	i r c	s	8	9
Townsend No. 19	p	8.5	May 16	June 8	June 27	8.8	m to l	r c	s	8.5	8.5
Warfield	p	9	May 10	June 7	July 2	9	m	l c	d c	8.5	9
Weston	p	9	May 16	June 17	July 5	8.5	l	b c	b s	8	8.5
Williams	b	8.5	May 14	June 14	July 5	8	m to l	r c	d c	8.5	9.3
Woolverton	b	8.5	May 14	June 14	July 3	8	m	l c	d c	8	9

NOTES ON VARIETIES.

The following varieties fruited for the first time the past season:

Aroma.—Plants from Thompson's Sons, Rio Vista, Va.

The plants are of strong and vigorous growth and make runners well. The roots are large, go down deep and have numerous fibers at lower end. Berry large in size, long conical form, color light scarlet, seeds prominent, flesh light, of good quality and very firm. Valuable for strength and vigor of plant growth, ability to resist drouth and for the firmness of the fruit. The frost injured the blossoms so badly that a fair estimate of productiveness could not be made.

Bixler's Seedling.—Plants from C. G. Bixler, Three Rivers, Mich.

The plants are of strongest growth. A good plant producer and a deep rooter. Berry of medium size, round, depressed conical in form, and of light scarlet color. Quality of the best and the fruit is moderately firm. Frost injured blossoms badly. Valuable for vigorous plant growth and high quality of fruit.

Cyclone.—Plants from Thompson's Sons.

The plants are of very strong growth, fruit stalk long, reclining, blossoms turned down, making it a good frost resisting sort. The roots go down deep, strongly aiding the plants to make growth in dry seasons. Berry of medium size, long conical, dark crimson color, flesh dark. Quality excellent and the fruit firm. Valuable for strong growth of plant, high quality and firmness of fruit and its ability to withstand drouth and frost.

Early Jack.—Plants from Stayman & Black, Leavenworth, Kan.

The plants are of good growth and are strong, deep rooters; row well filled out. Berry of medium size, round conical form, very light scarlet color and flesh light. The quality is not good and the fruit lacks firmness. An early ripening sort. Requires further trial.

Edith P.—Plants from Thompson's Sons.

The plants are of rather weak growth, did not start well. The plants set in the spring of 1895 are doing well and seem to have strong roots. The plants are of low growth, hug the ground. Berry of medium size, round conical form, color very dark crimson, of high quality and quite firm. A further trial is necessary to properly judge of merits.

Fred Stahelin.—Plants from F. C. Stahelin, Bridgman, Mich.

Plants quite strong growing. Blossoms considerably injured by frost, but recovering well. Berry large, short round conical in form, color very dark crimson, seeds yellow, slightly prominent, flesh very dark red and of best quality, though lacking in firmness. The variety resisted frost well and the attractive appearance and high quality of the fruit gives promise of a valuable sort for home use or near market.

Kyle No. 1.—Plants from Wm. C. Babcock, Bridgman, Mich.

The plants are of strong growth. Blossoms badly frosted and few left to set fruit. Berry of medium size, round conical form, color light scarlet, seeds prominent, flesh light in color, of poor quality and soft. Calyx parts very easily. Must try again in a more favorable season.

Longfield.—Plants from Stayman & Black.

The plants are not of strong growth, quite scattering and made but few runners. Plants and blossoms but little injured by frost, fruit stalk short and close branching, blossoms turned down. Berry large, round or broad conical, dark crimson color, flesh medium dark, good quality and firm. A very promising market sort, will stand shipment well and is attractive in appearance.

Marshall.—Plants from Prof. S. T. Maynard, Amherst, Mass.

The individual plants are quite strong but did not make many runners. The plants set in the spring of 1895 have made a well filled row and seem to be strong, deep rooters. Blossoms badly frosted. Berry large, round depressed conical, largest in center, color a bright crimson, seeds prominent, flesh rather light in color, but of excellent quality and quite firm. A variety of much promise. Quite liable to rust.

Maxwell.—Plants from Thompson's Sons.

The plants are of quite strong growth. The roots do not go deep, but have numerous fibers at lower end. Blossoms stood frost well, turned downward. Berry rather small in size, form round conical, dark crimson color, seeds prominent, flesh quite dark, of high quality and moderately firm. A promising sort.

No. 16.—Plants from Stayman & Black.

The plants are of fairly strong growth. Blossoms frosted badly and but little fruit borne. Berry large, round conical in form, dark scarlet color, seeds even, of fair quality and moderately firm. Requires further trial.

No Name.—Plants from Thompson's Sons.

The plants are of very strong vigorous growth and are deep, strong rooters. Most of the early blossoms were killed by frost, but the plants recovered and sent out more. Berry large, broad conical, somewhat irregular in form, dark crimson color, does not ripen well at tip, seeds

yellow, prominent, flesh dark, of excellent quality and firm. Very handsome in appearance, an excellent shipper, of good quality and stands frost well.

Phillip Seedling.—Plants from Slaymaker & Son, Dover, Del.

The plants are of good, vigorous growth and are strong, deep rooters. But few blossoms appeared and little fruit borne. Berry large in size, form round conical, dark crimson color, seeds yellow, prominent, flesh dark, not of high quality and rather soft. The fruit is attractive in appearance but so little was borne that a fair estimate of value cannot be made.

Rio.—Plants from Thompson's Sons.

Some of the plants are of strong and vigorous growth, but the row is somewhat scattering. The roots are numerous and fibrous but do not go deep. Blossoms quite badly frosted. Berry of medium size, round or long conical in shape, bright scarlet color and seeds prominent, flesh rather light, of excellent quality, but somewhat lacking in firmness. Cannot judge properly of merits, but the variety is certainly one well worthy of further trial.

Robinson.—Plants from Edw. W. Cone, Menomonie, Wis.

The plants are of good growth, roots are not numerous, but go down deep. Blossoms badly frosted, but plants sent out more and bore a fair crop of fruit. Berry medium size, round or broad conical, bright crimson color, flesh light, poor in quality and very soft. Further trial necessary.

Shawnee.—Plants from Stayman & Black.

A few plants are of strong growth, the others did not get a good start. Blossoms badly frosted, but plants recovered fairly well. Berry of medium size, form long conical, usually with neck, color dark crimson when fully ripe, quality good, moderately firm. Does not ripen evenly. A variety of much promise.

Shuckless.—Plants from Slaymaker & Son.

The plants are of fairly vigorous growth. Blossoms but little injured by frost. Berry of good size, round conical in form, dull crimson color, seeds prominent, flesh light, lacking in quality and firmness. The berry parts easily leaving the calyx on the stem. The variety does not seem to have much of promise in it.

Smith Seedling—Plants from Slaymaker & Son.

The plants are not of very strong growth. Blossoms quite badly frosted. Berry rather small in size, round conical, bright scarlet color, flesh light, of fair quality and moderately firm. A few berries were ripe June 1. It was the earliest variety to ripen fruits of any grown this year. Not sufficiently tested.

Snowball.—Plants from Edw. W. Cone.

The plants are very strong growing and healthy. Blossoms quite badly injured by frost, but the plants recovered well. Berry medium to large in size, long conical with neck, bright scarlet color, seeds dark, not prominent, flesh light, quite acid in flavor, firm. The plants are healthy and of good growth. The fruit is handsome in appearance and a good shipper. Regard it as a very promising variety.

Springdale.—Plants from Stayman & Black.

Of fairly strong and vigorous growth. A good rooter. Blossoms somewhat injured by frost, but others came on and the plants bore a large crop of fruit. Berry large in size, form round or long conical, color bright scarlet, of medium quality but firm.

The plants are of excellent growth and very productive. The fruit is of regular form, handsome in appearance and a good shipper. A variety of much promise.

Tennessee Prolific—Plants from Slaymaker & Son.

The plants set in 1894 are of weak and scattering growth, those set in the spring of 1895 are among the strongest in the patch and are deep and strong rooters. But little fruit borne. Berry large in size, shape round conical, bright, dark crimson color, flesh dark, of good quality and modeately firm. Handsome in appearance, but not enough fruit borne to judge fairly of value. Appears promising.

Timbrell—Plants from Slaymaker & Son.

The individual plants are of good growth, but made few runners, roots are numerous, fibrous and go down deep. Few blossoms appeared, but they were little injured by frost. Berry large, round conical, very dark crimson, almost black when fully ripe, flesh rather light in color, of good quality, but not firm. Does not ripen evenly, appears spotted until fully ripe. Apt to be picked before it is ripe. Requires further trial.

Thompson No. 40.—Plants from Thompson's Sons.

The plants are of excellent growth and the row well filled out, the roots are numerous and go down deep. Blossomed early but resisted frost well and bore a large crop of fruit. Berry of medium size, round conical, bright crimson color, seeds prominent, flesh dark and of very good quality, moderately firm. Fruit handsome in appearance. Plants of vigorous growth and productive. Very promising.

Thompson No. 64.—Plants from Thompson's Sons.

Some of the plants are of good growth; few roots but they go down deep. Most of blossoms came out late and were little frosted. Berry of medium size, long conical form, dull crimson color, of good quality and firm. Did not bear much fruit, but the variety has much promise in it.

Tonga.—Plants from Stayman & Black.

The plants are of vigorous growth and are good rooters. But few blossoms appeared and these were considerably frosted, so little fruit ripened. Berry medium in size, round conical, quite irregular in form, dull scarlet color, seeds prominent, of fair quality and firm. Requires further trial.

The following new sorts did not make sufficient plant growth, or were so badly injured by frost that little could be said of them and description will be postponed until another season's trial shall give more data upon which to form an opinion:

Australian, *Annie Laurie*, *Columbus*, *Equinox*, *Jarbola*, *Kossuth*, *Ona*, *Oscar*, *Ostego*, *Richmond*, *Smalley* and *Yahoo*.

NEW VARIETIES OF 1894.

The behavior of varieties during so unfavorable a season as that of 1895 should give valuable data toward determining their place in comparison with the older and standard sorts.

Bird, *Charlie*, *Jay Gould* and *Princeton Chief* were of vigorous plant growth and had deep, strong roots. They withstood frost well and bore, for the season, a large crop of fruit. Bird and Jay Gould are especially valuable as market sorts on account of the handsome appearance, good quality and firmness of their fruit. Charlie and Princeton Chief are somewhat lacking in firmness of berry; they will doubtless find a place in the home garden or for near market use.

Long John. If this variety were a good plant producer it would be a most valuable sort. More berries were borne on these plants than on than on those of any other sort in the field. It blooms late and the blossoms are protected from frost by the leaves of the plant. The fruit is moderately firm, of fine appearance and good quality. As a variety for culture in hills, it is excelled by few sorts.

Allen No. 13 has again shown its superiority over the several other numbers received here for trial. There is much of promise in the variety. Fruit of good size, fine appearance, regular form, good quality and firm.

Brandywine in plant growth was not so vigorous as last year and the blossoms were badly affected by frost. Still promising for home use or near market.

Childs, Judsonia, and *Seedling B.* are varieties having considerable merit but are unlikely to ever reach great prominence.

Bowman, Chairs, Dan Bisel, Luther and *Sandoval* did very poorly the past season. They will be given further trial under more favorable conditions.

Of the somewhat newer sorts but including those that have been tried for three or more seasons, *Greenville, Leroy* and *Weston* still hold a high place. The plants are of strong growth and productive. The berries are of good form and color and sufficiently firm to stand shipment well.

Clyde did not hold out in promise. Others report it as not of much value.

Feicht No. 2, Huntsman and *Topeka* were wanting in vigor of plant growth. When the season is a favorable one, they are valuable as home market sorts.

Epping was vigorous in plant growth and bore a good crop. The light color of the fruit is against it as a market berry.

Allen No. 1 was so badly frosted as to greatly lessen the otherwise excellent prospects of the variety.

Iowa Beauty on account of the high quality and handsome appearance of the fruit should find a place in every home garden.

Brunette which has previously ranked above Iowa Beauty as a home variety did not do well the past season. The plants seem to lack ability to form good, strong roots, and it was injured by the drouth.

Cameron No. 2 and *No. 4 J. S.* were far above the average in plant growth and productiveness.

Leader and *Williams* are likely to occupy a prominent place as market sorts. Reports from localities where they have been on trial have been very favorable.

Swindle is quite liable to rust badly, otherwise a valuable sort.

Nims' Seedling is excellent in plant growth and productive of good sized berries. It has a long season and holds out well to the end. The color of the fruit is light, but the variety is likely to find a place for home or near market use.

Afton. This variety is very similar if not identical to Warfield in plant growth, productiveness and in form, color and firmness of berry.

Mrs. Cleveland and *Sadie* are well worthy of notice as home or near market sorts. The plants are of excellent growth, productive, and the fruit handsome in appearance. These varieties have been tried here for a number of years and with uniformly good results.

Klickita, Lovett Early and *Surprise* bore large crops of good fruit during the past unfavorable season.

The following sorts have some good points, but they are deficient in others and there is little chance of their occupying a prominent place:

Alabama,	Henry Ward Beecher,	Pawnee,
Banquet,	Kansas,	Princess,
Bickle,	Lincoln,	Standard,
Cameronian,	Magnate,	Smeltzer's Early.
Gypsy,	Neptune,	

The varieties named below have few points of merit and most of them will be placed in the rejected list:

Accomac,	Feicht's No. 3,	Mystic,
Allen No. 3,	Glenfield,	Odessa,
Belt No. 3, (Wm. Belt)	Hattie Jones,	Primate,
Beverly,	Hermit,	Southard,
Cameron No.'s 6 and 13,	Katie,	Stevens,
Cheyenne,	Leviathan,	Westlawn,
Clark,	Little No.'s 18, 26 and 42,	Wyoming.
Fairmount,		

Belle and *Parker Earle* blossom late and thus often escape early frosts. The plants are of good growth and have proved very productive for many seasons. They are excellent market berries.

Bubach, *Crescent*, *Haverland* and *Warfield* are the leading pistillates planted by the general strawberry grower. The inability of the Warfield to withstand drouth proved a serious fault the past two seasons.

Beder Wood and *Woolverton*, in addition to being most excellent pollenizers for the pistillate sorts, are also valuable market berries. Wilson is also used as a fertilizer but its use is not so general as a few years ago.

The severe frosts occurring during the blossoming period gave an excellent opportunity to notice if any varieties were better able to resist frost than others. The two hundred varieties were carefully examined in sex and position of blossom, number and size of petals and sepals, and in length and position of fruit stalk and habit of growth of plant.

The examination seemed to warrant the following conclusions:

1. The pistillate varieties were much less injured by frost than the staminate, other conditions being equal.

2. The perfect flowering sorts that have large sized, irregular blossoms with numerous petals and sepals were most injured unless the blossoms were protected by the plants or turned downward.

Examples—Wm. Belt, Brandywine and Lower.

3. Varieties having the blossoms erect and thus exposed to the full effects of frost were badly injured. Examples—Huntsman, Epping and Lovett Early. Those sorts having blossoms turned downward, as Afton, Belle of Lacrosse and Princeton Chief, were able to carry many blossoms through uninjured.

4. Varieties having a short and reclining fruit stalk or one that is protected by the foliage of the plant, as Mrs. Cleveland, Sadie and Warfield, stood frost better than varieties like Mystic, Pawnee and Richmond, having upright fruit stalks.

5. Varieties that blossom late, often escape a frost that severely injures those that blossom earlier. Among late blooming sorts are Belle, Gandy, Neptune and Parker Earle.

6. Some varieties seem to recover from frosts and send out new blossoms much better than others. Among those sorts that recovered well may be named Bubach, Haverland, Leroy, Judsonia, No Name, Princess, Shawnee and Snowball.

RASPBERRIES.

The bushes were sprayed thoroughly with Bordeaux mixture just before growth started in the spring. The treatment was repeated when the new growth was about one foot high, special pains being taken to apply the spray to the new growth. While the old wood of many varieties was badly affected with anthracnose, the new canes are in good condition for next season's crop.

The raspberries suffered much from the dry weather and extreme heat during the ripening season. The bearing period was so shortened by the drouth that the dates of last ripening of fruits is omitted.

BLACK AND HYBRID RASPBERRIES.

ABBREVIATIONS.

Size.	Form.	Color.	
s, small.	r, round.	b, black.	g, glossy.
m, medium.	c, conical.	p, purple.	l, light.
l, large.	o, ovate.	o, orange.	pu. pubescent.

Variety.	Vigor (1-10).	Date bloom.	First ripe fruits.	Productiveness, (1-10).	Size.	Form.	Color.	Quality.
Ada	9.5	June 3	July 1	9.0	m	r	g b	8
Caroline	9.0	May 31	July 1	7.5	m	r	l o	8
Columbian	9.5	June 3	July 3	9.8	l	r o	p	8.5
Conrath	9.3	May 31	June 29	9.0	l	r	b	8
Cromwell	7.5	May 31	June 25	7.0	m	r	b	8
Ebon Beauty	8.5	May 31	July 1	6.5	m	r o	b	7
Farnsworth	9.2	May 31	July 1	9.0	l	r	b	8.5
Gregg	9.5	May 31	July 3	9.3	l	r	b pu	7
Hopkins	8.5	May 31	June 29	6.0	m	r	b	8.5
Jackson's May King	8.5	May 28	June 27	7.0	s	r o	b	7.5
Johnston Sweet	5.0	May 31	July 1	6.0	m	r	g b	8
Kansas	9.5	May 31	June 28	9.8	l	r	g b	8.5
Lovett	9.0	May 31	June 29	7.5	m	r	b	9
Nemaha	9.2	June 3	July 5	7.0	l	r	b pu	7
Norfolk	8.0	May 31	June 29	7.0	s	r	b	8.5
Older	9.5	May 31	July 1	9.0	l	r	b	9
Ohio	9.5	May 30	June 30	8.5	l	r	b	6
Palmer	8.5	May 28	June 25	8.5	m	r	b	8.5
Progress	9.0	May 31	June 27	7.5	m	r	b	8.5
Shaffer	9.3	June 6	July 3	9.0	l	r o	p	8.5
Smith (Prolific)	8.0	May 31	June 27	8.5	l	r	b	9
Surrey	8.5	May 31	July 2	8.5	l	r	b pu	8.5
Virginia	9.0	May 28	June 25	5.0	l	r c	b	8.5
Winona	8.7	May 31	June 25	8.0	m	r	b	8
Wonder	8.2	May 31	July 1	7.0	s	r	b	8

NOTES ON VARIETIES.

Ada.—The bush is quite vigorous, and withstood drouth and attacks of anthracnose as well as any of the blacks. Few blossoms were injured by frost and a good crop of good sized fruit of fair quality was borne. An excellent sort.

Caroline.—If one desires a sort bearing yellow fruit, this is one of the best.

Columbian.—Growth of cane strong and vigorous and but little injured by winter. Blossoms not hurt by frost. This variety bore more fruit than any other in the plantation and was taken as the standard of productiveness. Columbian differs from Shaffer in being of stronger and larger cane growth; the new canes lack the purple tinge of Shaffer and the spines are fewer in number, but are considerably larger in size; the leaflets of Columbian are also larger than those of Shaffer. The berry closely resembles Shaffer but is drier, more seedy and a little better in quality. Toward the close of the season the old canes were badly injured by anthracnose.

Conrath.—Canes slightly injured by winter. Seven per cent of blossoms killed by frost. The plant is fairly vigorous and is productive. The fruit is of large size, firm and of fair quality. It is medium early and holds out well in season. Considerable anthracnose toward close of season. Growth of new canes excellent.

Cromwell.—Canes injured considerably by winter; 25 per cent of blossoms killed by frost. Canes badly affected by anthracnose and drouth. An early ripening sort but did not do well the past season.

Ebon Beauty.—Somewhat injured by winter and considerable anthracnose on old canes. Few blossoms killed by frost. Fruit rather small in size, round conical in form, deep black with considerable down, is quite soft and rather poor in quality. Of fair cane growth.

Farnsworth.—Stood winter well. Quite free from anthracnose and but few blossoms killed by frost. The plants are vigorous, healthy and productive. The fruit is large, firm and of good quality. An excellent variety for home use or market.

Gregg.—Canes quite badly killed back by winter. Ten per cent of blossoms frosted. Old canes have considerable anthracnose. Bore a good crop of large sized fruit. The best late market sort.

Hopkins.—Badly winter killed. Twenty-five per cent of blossoms injured by frost. Bush of weak growth. Fruit small, of fair quality but soft and a small quantity borne.

Jackson's May King.—Bush of fair growth and stood winter well. Seven per cent of blossoms killed by frost. Fruit rather small in size, round conical, jet black with considerable down between seeds, not of very good quality. Did not bear much fruit. Old canes dying with anthracnose and from drouth before crop matures.

Kansas.—But little injured by winter. Some disease on old canes. New growth strong. Five per cent of blossoms frosted. This was the most productive black cap grown this season. The fruit is large, jet black, firm and of fair quality. A most excellent medium season sort.

Lovett.—Quite badly winter killed. Much anthracnose on old canes. Ten per cent of blossoms injured by frost. Fruit small in size and but a small crop borne. There are better sorts ripening at the same season.

Nemaha.—Quite badly injured by winter. Bushes did not do well the past season and but few berries borne. Usually a good late ripening sort.

Norfolk.—Nothing special to recommend it. Others better.

Older.—But little injured by winter. Much less disease than most other varieties. Few blossoms frosted. Bush of vigorous growth and productive. The fruit is of large size, rather soft but of high quality. An excellent sort for home use or near market.

Ohio.—But little injured by winter. Twenty per cent of blossoms frosted. Considerable anthracnose but bushes bearing a good crop of fruit. One of the best medium season market sorts. The leading variety for evaporating purposes.

Palmer.—Canes injured somewhat by winter but not badly. Ten per cent of blossoms killed by frost. A good early market variety.

Progress.—Very similar to Palmer, though scarcely as productive.

Shaffer.—For canning and home use this variety has no superior among the better known sorts. Quite badly injured by winter.

Smith (Prolific).—Canes were most injured of any variety by severe winter. Badly affected with anthracnose. Twenty per cent of blossoms killed by frost. The bush is of strong growth and fairly productive. The fruit is large, jet black, not very firm, but of good quality. A good variety.

Surrey.—Canes but little injured by winter. Ten per cent of blossoms killed by frost. Bush vigorous and healthy. Fruit closely resembles that of Gregg, but is not so late in ripening.

Virginia.—Canes winter killed but little. Thirty per cent of blossoms injured by frost. Bush not of vigorous growth this season, but little disease present. An early ripening sort. In past seasons this variety has done well.

Winona.—Canes were injured by winter, but not badly. Few blossoms killed by frost. Much disease on old canes. New growth excellent. Fruit of medium size, round conical, black with considerable down, seeds rather large, lacking in quality and firmness. Not sufficiently tested.

Wonder.—Tips of canes winter killed. New growth strong. Considerable disease on old canes. Ten per cent of blossoms injured by frost. Fruit large, jet black with down between seeds, good quality but not very firm. Requires further trial.

RED RASPBERRIES.

ABBREVIATIONS.

Size.	Form.	Color.	
s, small.	r, round.	d, dark.	o, orange.
m, medium.	c, conical.	r, red.	b, bright.
l, large.	o, ovate.	p, purple.	

Variety.	Vigor (1-10).	Date bloom.	First ripe fruit.	Productiveness (1-10).	Size.	Form.	Color.	Quality.
Arnold	9	June 3.	July 3.	6	v l	o	b r	9
Brandywine	9.8	June 5.	July 8.	8.5	m	r o	d r	8
Cuthbert	9.5	June 5.	July 3.	9.5	l	r o	r	8
Gladstone	8	June 3.	July 2.	8	s	r o	d p	8
Golden Queen	9	June 5.	July 6.	8.5	l	r o	o	9.5
Hansell	9	June 3.	June 27.	8	m	r	d r	9
Lost Rubies	9	June 3.	June 27.	8.5	l	r o	b d r	9.5
Marlboro	8	June 3.	June 27.	9	m	r	r	8.5
Michigan Early	8.5	May 31.	June 25.	8.5	m	r	r	9
Philadelphia	8	June 3.	June 27.	7	l	r c	d r	9.5
Rancocas	8	May 31.	June 26.	8	m	r	r	8.5
Royal Church	8	June 3.	July 1.	8.5	l	r c	d c	8.5
Scarlet Gem	6.5	June 3.	June 26.	6	m	r	b r	9
Thompson Prolific	8.5	June 3.	June 26.	7	m	r	d r	9
Turner	9.3	June 3.	June 27.	9	l	c	r	9

NOTES ON VARIETIES.

Brandywine.—Stood winter well. Growth of cane vigorous and healthy. Fruit of medium size, bright red color, quite firm and of fair quality. It is a late ripening sort of some value.

Cuthbert.—But little injured by winter. The plant is vigorous and healthy. The variety has yet no superior for general planting.

Gladstone.—Canes hardy but quite badly affected with anthracnose. New growth good. The fruit when ripe is purplish, soft and of fair quality. The variety if valuable at all is only so as a continuous bearer. The bushes bore a large crop of fruit in October.

Golden Queen—The bush is hardy and of vigorous growth. The fruit is clear, bright yellow in color and of high quality. It is a desirable variety for the home garden.

Hansell and *Michigan Early* are hardy in plant and fairly productive. As early ripening sorts they may find a place to a limited extent.

Marlboro.—The bush is hardy but not of very strong growth. It occupies a prominent place as an early ripening market berry.

Royal Church.—The bush is hardy, of vigorous growth and quite productive. The fruit is of dark, rich crimson color, and good quality, but crumbles easily.

Turner.—The bush is extremely hardy, of good growth, and productive. The fruit is of high quality but soft. Valuable for home use or for near market.

Arnold, Lost Rubies, Philadelphia, Rancocas and *Scarlet Gem* are now but little grown. Their place being taken by better varieties.

BLACKBERRIES.

The severe winter of 1894–5, gave a good opportunity to observe the hardiness of the several varieties grown here.

Early King.—Quite badly injured by winter but some of canes left. Canes of upright growth. Leaves light green, rather small and pointed. Few blossoms left uninjured by frost. Fruit very large; seeds large, round, loose; very sweet and has a small core. More hardy than any other early sort grown here.

Eldorado.—Stood winter as well as Snyder. New growth good. Most of blossoms killed, and the fruit remaining is imperfect. Closely resembles Snyder in cane and growth, though leaflets are a lighter green and the cane has more red with larger and longer spines. A very promising, hardy sort.

Lincoln.—Stood winter almost of well as Snyder. New growth excellent. No fruit.

Minnewaski.—Stood winter fairly well. New growth very strong. No fruit.

Snyder.—Quite badly injured by winter. Canes killed half of length. New growth strong. Bore but little fruit.

Stone's Hardy.—Did not stand winter as well as Snyder, but some cane growth left. Bore little fruit.

Taylor's Prolific.—Stood winter about the same as Stone's Hardy. Some fruit, but small and imperfect.

Agawam, *Jewett* and *Kittatinny* were killed nearly to ground. No fruit borne.

Child's, *Early Cluster*, *Erie*, *Ford's No. 1*, *Ohmer*, *Wilson's Early*, *Wilson's Jr.*, and *White Blackberry* were killed to ground and bore no fruit.

AGRICULTURAL COLLEGE, MICH.,
February 1, 1896.

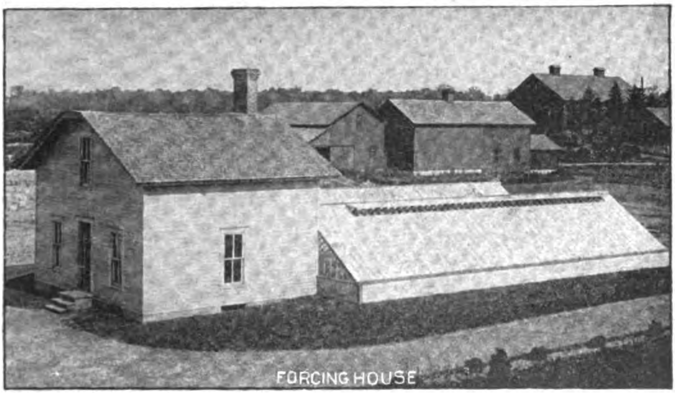
BULLETIN 131 APRIL, 1896

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

HORTICULTURAL DEPARTMENT



131 POTATOES.

VEGETABLE TESTS.

AGRICULTURAL COLLEGE, MICHIGAN
1896

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No. 65. Planting for Honey.
67. Fruit Tests at South Haven Station.
68. The Jack-pine Plains.
69. Feeding Steers of Different Breeds.
73. Kerosene Emulsion. Some New Insects.
77. Comparing the Yield of Old Meadows with those Recently Planted.
78. Glanders and Farcy.
79. Vegetable Tests.
88. Fruit Report.
90. Vegetable Tests.
98. Locusts and the Horn Fly.
103. Peach and Plum Culture.
105. Michigan Fruit List.
113–16. (In one volume.) Fattening Lambs. Rape as a Forage Plant. Management of Swamp Lands. Insects in the Clover Field.
117. Millet.
118. Fruits at South Haven.
121. Pests of the Orchard and Garden.
125. Crimson Clover and Other Topics.
126. Fertilizer Analyses.
127–28. Dairy Records. Fattening Lambs.
129–30. Fruits at South Haven. Fruits at the Agricultural College.

I. H. BUTTERFIELD,
Secretary.

BULLETIN 131 APRIL, 1896

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

HORTICULTURAL DEPARTMENT

POTATOES . .
. . VEGETABLE TESTS

By L. R. TAFT, H. P. GLADDEN AND U. P. HEDRICK

AGRICULTURAL COLLEGE, MICHIGAN
1896

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.

POTATOES.

BY L. R. TAFT.

The experiment work with potatoes during the past season included a test of ninety varieties, about one-half of which had been grown for at least two years previously; tests of various fertilizers and mixtures of several of the more common chemical manures; the use of several fungicides to prevent potato scab and of a number of chemicals to test their effect in increasing the amount of scab, besides a considerable amount of work along the lines of the best distance to plant, the use of the tip ends and the effect that could be produced by selecting the seed towards increasing the yield.

THE TEST OF VARIETIES.

The land used for this test is near the northeast corner of the vegetable garden; it is a moderately heavy loam, consisting of a mixture of sand and clay with a fair amount of humus. Strawberries were grown upon the same tract for the two previous years, and in the fall of 1894 it was top-dressed with stable manure and plowed.

At the date of planting, June 8, the soil was very dry and as a result they were slow in starting and the stand was not as even as would be desirable. Had the ground been thoroughly irrigated before planting much better results would have been obtained.

The ground was furrowed out with a plow, making the rows three feet apart, and each variety was given a space two rods in length; two pounds of seed was used of each sort and this was cut into twenty-two pieces, making the hills eighteen inches apart. At the end of a week the land was worked with a Breed weeder, which killed all weeds that had started and loosened the soil so as to aid the plants in making their way to the surface. The same tool was used once a week until the plants reached the height of six inches, after which the ground was worked with a narrow shovel cultivator which stirred the soil to the depth of three inches and left it level.

During the season three irrigations were given, the first being on the 2d of July and the others at intervals of three weeks. Enough water was applied, by running it into furrows made between the rows, to cover the ground to the depth of one inch at each application, or about eight hundred barrels per acre. About one-third of the varieties were new sorts and as nothing was known in many cases of their season, they were arranged alphabetically. On this account it became necessary in order to keep up the growth of the late kinds, to water the early varieties later than was desirable, and for this reason many of them did not ripen as early as they otherwise would have done, and as the dates taken of the

gives something of an idea of the conditions under which he was laboring at that time, and we cannot do better than quote the first part of it which reads as follows:

"I send you by mail a box of climbing cutworms that have been damaging my orchard. They are still at work, but the foliage is so large and tough now that they do but little damage. They like the tender buds and shoots, but will eat anything if they cannot get the buds. They are also at work at my grape vines. We have killed as many as 1,500 on some trees; not all in one night, but I did kill on a tree the other night 412, and the next night 114, and the next night 141 on this same tree, at one time, where I had been hunting them for two weeks before. I did not have time to count them very often as I have between four and five thousand trees. They have ruined a half or two-thirds of my crop. They go straight to the top of a tree and leave the lower limbs. The tops of some of my trees look as though they were dead, while the bottom limbs are white and full of blossoms."

This statement is a very moderate one, for the next season Mr. Rood and myself found them equally as abundant in a portion of his orchard.* On trees in a neighboring apple orchard, where the climbing cutworms had not been killed the year previous, we repeatedly counted from 500 to 800 cutworms on the trunk of a single tree by ten o'clock at night. These trees were probably twelve years old and about eight or ten inches in diameter. They were in timothy sod. Mr. Rood's orchard had been in clover sod for two years preceding, and much of it had died out the fall before the cutworms were the worst.

HOW, WHEN AND ON WHAT THEY WORK.

Climbing cutworms make their appearance in the spring as soon as the soil is moderately warm. This is sometime in April, and before the last of May the injury of the season by them is over. They are rarely abundant more than two or three weeks, and, by the time the apple trees are through blossoming, the cutworms are for the most part gone. They work exclusively at night, and the darker the night the more plentifully they appear. About eight o'clock in the evening they begin traveling, and by nine o'clock their movements remind one of the activities on a business street in a large city. By daylight they have again disappeared and all is quiet. They have buried themselves in the soil for the day or hid under some loose rubbish that may afford them shelter from the hot sun.

If one watches them on their nocturnal raid, he will see the most of them coming from the soil within a radius of five feet from the trunk of the trees, but others can be seen that start far beyond even where the branches of large trees reach. They usually take quite a direct course to the nearest tree, and in climbing it the tendency is to go into or near the top of the tree, and the terminal buds will generally show their work first. Often only the central portion or tenderest part of the bud is eaten

* Report State Board of Agriculture for 1895, under Report of Consulting Entomologist.

into, but when the buds are not plentiful, the whole is eaten and sometimes the tip of the twig or the bark. When checked on the trunk by a

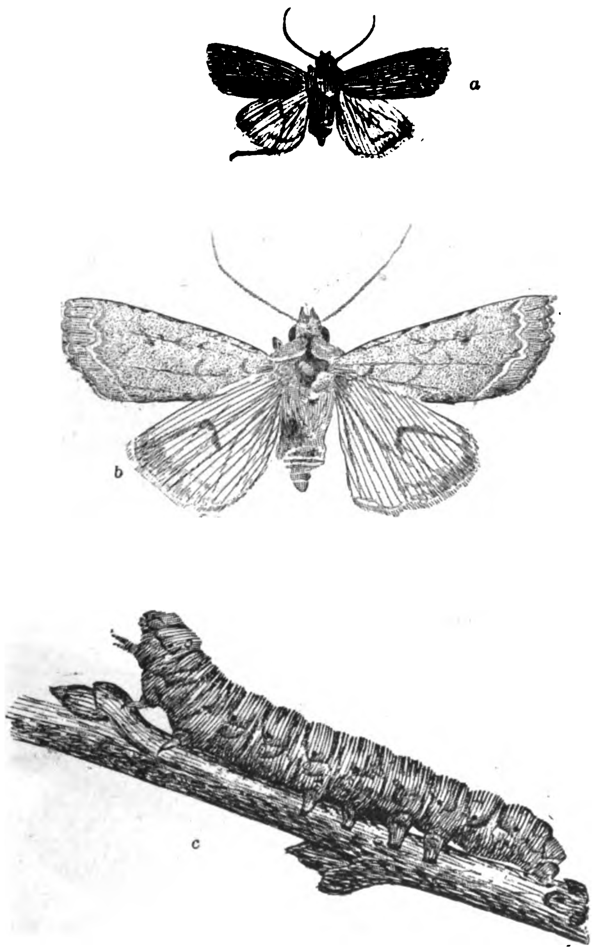

Fig 2.—The white cutworm, *Carneades scandens*: *a*, moth natural size; *b*, moth twice natural size; *c*, cutworm, twice natural size *(after Slingerland).

band, the caterpillars often become so hungry that they will girdle a tree beneath the band by gnawing off a part or all of the bark. If one listens under a tree at night, he can plainly hear the rasping of their jaws as they are at work on the buds.

Grape vines are particularly subject to attack from these cutworms, as they have such large, tender buds. Of the fruit trees perhaps the peach is the most likely to be attacked, as it is usually grown on sandy soil, but

* This and the four figures following have been modified from those of the Cornell Experiment Station to adapt them to the poorer quality of paper used in our bulletins.

the apple, plum and cherry suffer quite as much. The currant and berry bushes are also attacked, and in fact there are very few trees and bushes which are not known as food plants of the climbing cutworms.

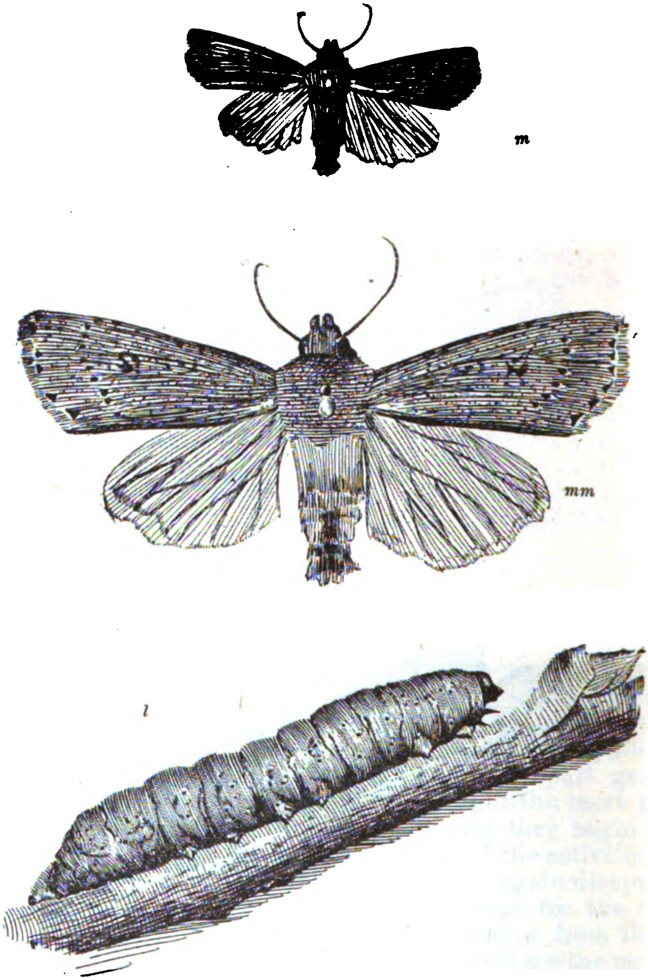

Fig. 3.—The spotted-legged cutworm, *Proeagrotis velusta:* m, moth, natural size; mm, moth twice natural size; l, cutworm, twice natural size (after Slingerland).

SPECIES KNOWN TO HAVE CLIMBING HABITS.

In a bulletin issued last November by the Cornell experiment station on "Climbing Cutworms of Western New York," Mr. Slingerland has prepared a comprehensive table of the species known to be climbing cutworms with date and references of first account of the climbing habit of each species and its common and scientific name. The table which I take the liberty to quote is as follows:

1852. Harris, Injurious Insects, p. 349.
The yellow-headed cutworm (*Xylophasia arctica* Bdv.).
1866. Riley, Prairie Farmer, June 2.
1869. Riley, First Missouri Report, p. 69–79.

The variegated cutworm (*Peridroma saucia* Hbn.).
The dark-sided cutworm (*Carneades messoria* Harr.).
The white cutworm (*Carneades scandens* Riley).
The well-marked cutworm (*Noctua clandestina* Harr.).
1883. Cook, Report Mich. Bd. of Agr., p. 422.
The black-lined cutworm (*Noctua fennica* Tausch.).
1887. Murtfeldt, Bull. 13 U. S. Ent. Div., p. 60.
The mottled-grey cutworm (*Rhynchagrotis alternata* Grt.).
The white-spotted cutworm (*Homohadena badistriga* Grt.).
1894. Davis, An. Rep't Michigan Expr. Station, p. 89.
The speckled cutworm (*Mamestra subjuncta* Gr. & Rob.).
1895. Davis, paper before Assoc. Ec. Ent., Aug. 28.
The red cutworm *Rhynchagrotis placida* Grt.).
1895. Slingerland, Bull. 104, Cornell Expr. Sta., p. 570 & 574.
The dingy cutworm (*Feltia subgothica* Haw.).
The spotted-legged cutworm (*Porosagrotis vetusta* Walk.).

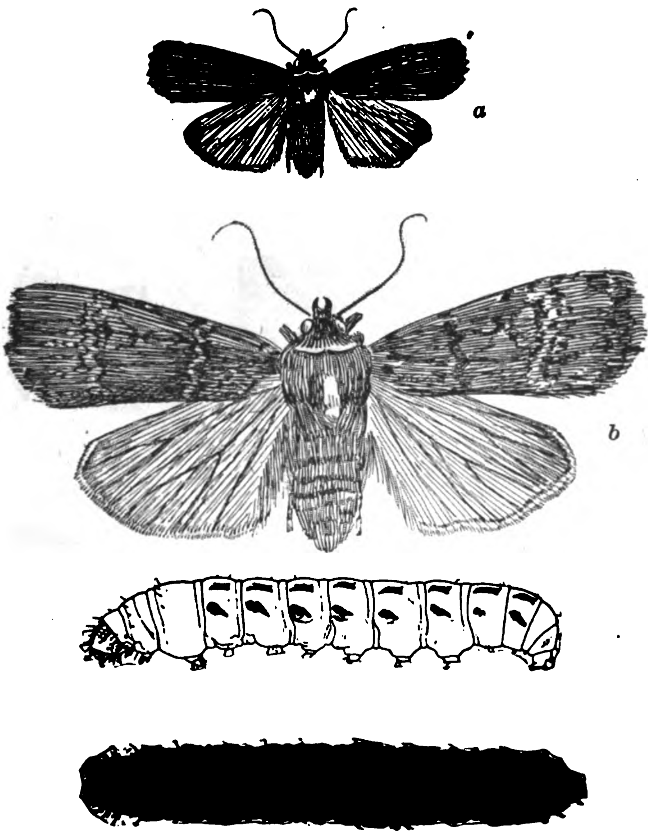

Fig. 4.—The well-marked cutworm, *Noctua clandestina:* Cutworm, beneath, side and back view, twice natural size (after Forbes). *a*, moth, natural size; *b*, moth, twice natural size (after Slingerland).

All or nearly all of these species are common over the eastern United States and Canada. The species found at Muskegon were the speckled, red, white and dark-sided cutworms. Of these fully nine out of every

ten were the speckled cutworm, *Mamestra subjuncta.* The red and white cutworms were usually present, but not abundant.

LIFE HISTORY OF THE SPECKLED CUTWORM.

When the caterpillars become full grown, they are about an inch and a half long. They are now through feeding and they bury themselves

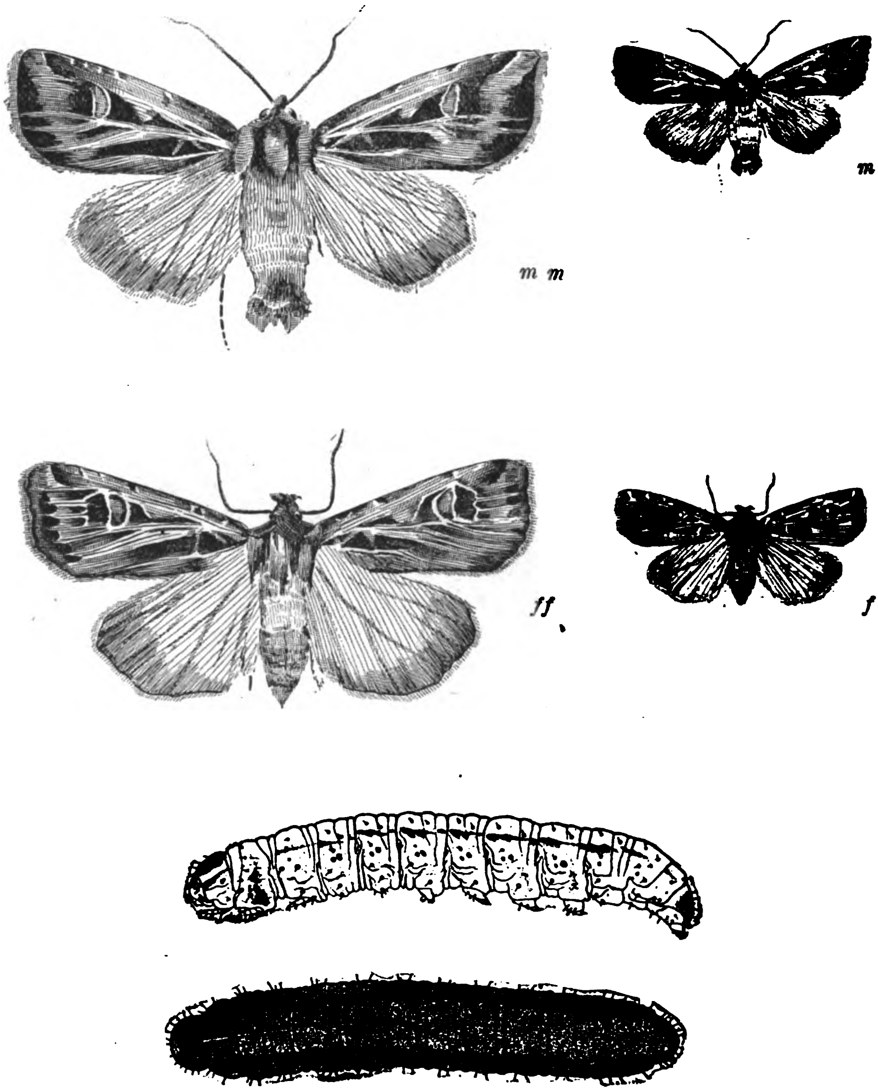

Fig. 5.—The dingy cutworm, *Feltia subgothica:* m and f, male and female moths, natural size; mm and ff, male and female moths twice natural size (after Slingerland). Beneath is side and back view of the cutworm, twice natural size (after Forbes).

deeper in the soil than when they were hiding through the day. Here each one constructs an oblong cell in the earth by the use of saliva, and pressure of the body, and in this cell it transforms to what is known as the pupa, or chrysalis. From the pupa stage they issue as a moth between the last of June and early August. These moths are the parents for the next year's brood of cutworms. They lay their eggs, according to Dr. Riley, in the fall in batches of from fifty to sixty and generally in

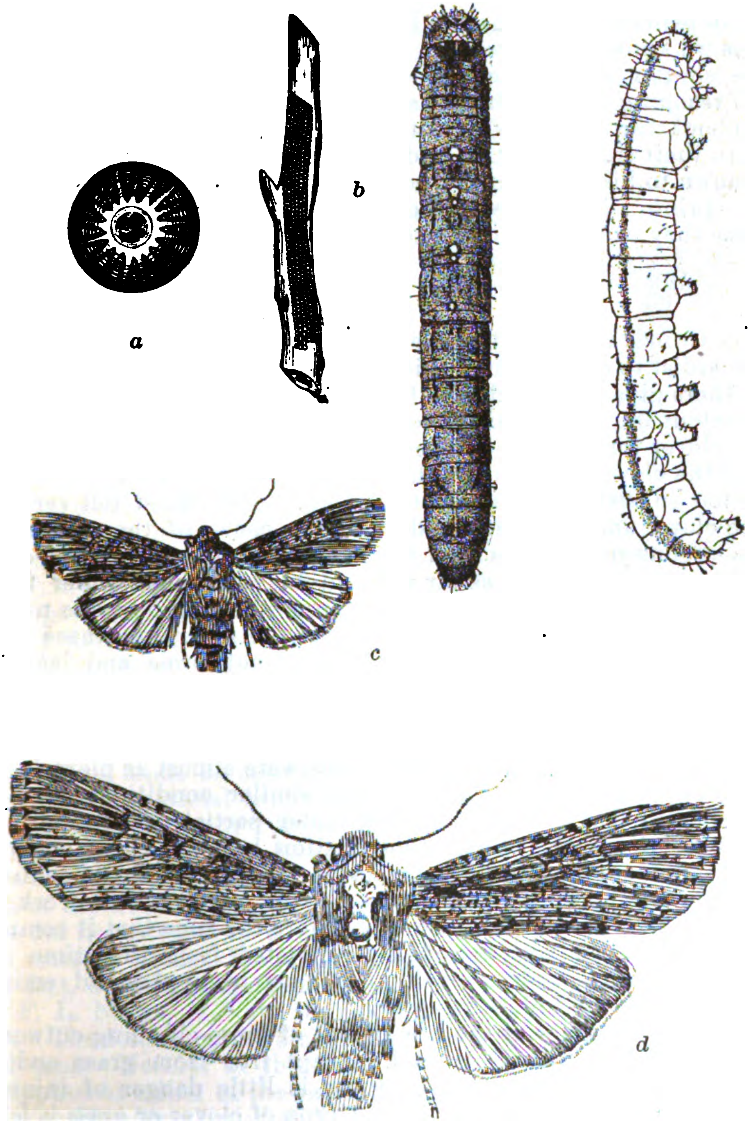

Fig. 6.—The variegated cutworm, *Peridroma saucia*: *a*, an egg greatly enlarged; *b*, cluster of eggs, natural size; *c*, moth, natural size; *d*, moth, twice natural size (after Slingerland). Side and back views of the cutworm, twice natural size (after Forbes).

two layers. The eggs probably hatch in the fall and the young cutworms partly mature on grass, or some similar green food before winter, as many other species whose habits are better known do. They never molest the fruit trees at this time of the year. In this partly grown condition they remain until spring, when they awake from their long fast to feed on the early vegetation. Their growth is very rapid at this time and in two or three weeks they are full grown and ready to follow in the line of their ancestors.

This in general is also the life history of our other destructive species as far as we known it at present. Some species remain in the pupa stage a much shorter time, which is the case with the red cutworm that is later in reaching its growth, but appeared in the breeding jar June 15th, or in about two weeks after attaining its growth. Other species are slower in their transformation and winter in the egg stage, and some are even known to hibernate in the pupa stage and appear as a moth the following spring. Undoubtedly these latter do no harm as climbing cutworms as they would be too late to injure the buds or tender leaves.

MEANS OF CONTROL.

CLEAN CULTIVATION.—There perhaps is no one item more important for the orchardist to observe than this. All of my observations and those of many others give good evidence that the climbing cutworms do not breed to any extent in carefully tilled soil. In Mr. Rood's case the orchard had been in clover for the past two years. Through the dry summer season, much of the clover was killed out, leaving enough still for the young cutworms too subsist on during the autumn. Mr. Rood felt very certain that the clover and its death had been the cause of the attack on his trees, and consequently, as soon as the attack in the spring was over, his orchards were plowed and, as far as could be, were kept under thorough cultivation for the remainder of the season, allowing no grass nor weeds to grow even close to the trunk of the trees. As a result these orchards were not molested last spring by climbing cutworms, and last fall he wrote me that he had never had a finer crop of apples or a larger yield. There was one orchard which had grape vines between the rows of trees. This was plowed and cultivated, but could not easily be kept entirely clean, and it was here that the cutworms were almost as plentiful as the year before. In neighboring orchards similar conditions were noted. Those orchards that were in old sod or under partial cultivation suffered the most severe attack. This same relation between clean culture and freedom from cutworms has been reported to us from Benzie county, and Mr. Slingerland found the same to be true in western New York. Had Mr. Rood plowed his clover under at or before the time that it commenced to die, and kept the soil thoroughly cultivated from that time on, the climbing cutworms would probably not have been plentiful enough to cause any injury the following spring.

From what we know of the life history of these climbing cutworms, it seems safe to say that if the ground is kept free from grass and weeds from July to October of each year, there is little danger of injury from climbing cutworms, and probably if a crop of clover or grass is left over *one* year and plowed under in June of the next, the cutworms will not increase to any great extent in this short period. This would give an opportunity for using wheat, rye or clover as a green manure if desired.

TRAPPING THE MOTHS.—This is an old method, long since discarded by those of experience in this line, but occasionally people ask regarding it; for this reason it is inserted here. In early times this appeared to be an ideal remedy, as it was thought that the moths could easily be caught before the female deposited her eggs. A few years' practice proved the fallacy, as most of the moths caught were males or old females. Moreover many beneficial insects were also taken in the same traps, and the harm nearly equalled the benefit.

THE TIN COLLAR was tried last spring, and was found to be little better than nothing. When the cutworm comes to the collar, it will travel around beneath until it comes to the lap or where the two ends meet, and then will climb up almost as readily as on the bark. The tin collar is more difficult to fit to the tree than the band, and is more expensive.

THE CONE-SHAPED PASTE-BOARD COLLAR.—This means of protection I have found in more general use over the State than any other one method. The collars are cut to a scale from stiff glazed paper, and, when pinned around the trunk, form an inverted funnel over which the cutworm must travel to go farther. These pasteboard collars were already on the grape vines on my arrival at Muskegon. Other bands were put on above to see if the collars were a success. We found no instance, to my present remembrance, where a cutworm was known to pass over the paper funnel, and if it fitted tightly, appeared to be a protection; but the collars could not be made to fit every little irregularity of the trunk with sufficient accuracy to prevent the cutworms from finding a crevice to push their way through, and hence many were found above the paper cone. The cones are also very easily tilted or moved in cultivating and working around the trees and vines, and this unintentionally opens more crevices.

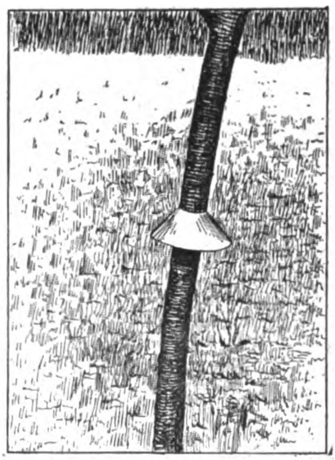

Fig. 7.—An illustration of a cone-shaped paste-board collar.

BANDS.—Three kinds of bands were tested in the orchard, viz.: Wool, cotton, and one of material from Germany, resembling wagon grease, and known as caterpillar lime or "*Raupenleim*."

The Caterpillar Lime was furnished by Wm. Menzel & Son, 64 Broad street, New York city, and did very nicely. It was applied directly to the trunk of the tree in a band of from one to two inches in width. The cutworms did not attempt to climb over it except on a very cool night when the material became too stiff. This defect can quite likely be overcome; in fact, a similar susbtance known as "Dendrolene," compounded by Prof. F. L. Nason, of New Brunswick, N. J., is said to obviate this difficulty. The former costs 13 cents and the latter 6 cents per pound in 25 pound cans. Neither of these materials, however, are as cheap or as quickly applied as either of the two following bands.

The Cotton Band was tested very thoroughly by Mr. Rood the first year, who says of it, "As long as the cotton is kept dry, it stopped their upward climbing, and there would be a great mass of moving worms just beneath the cotton. After it rained on the cotton, they walked right over it and

got in a good night's work. Next day, as I had no more cotton, I put a daub of tar on the top of the band. That worked like a charm for a while, but as soon as the tar got too cold and lost its smell, they trotted over it and I had to put on another coat."*

Fig. 8.—Illustrating the wool and cotton bands.

The next year there was no rain for the two weeks in which the cutworms were the worst, and the cotton bands protected as well as anything tried. After being wet it was hoped that the edges of the cotton band could be somewhat pulled to pieces and again made to protect, but in this we failed. The use of cotton batting for a band is therefore quite uncertain, and undesirable as the weather is usually rainy at the time of the year when the climbing cutworms are the worst, and they would do much harm before the bands could be replaced if a large orchard is to be protected in this way. A roll of cotton will make bands for a great many trees, and is the cheapest of all bands at the start, but may not be in the end. For this reason fruit growers will find that

The Wool Band is the cheapest and the best of all. It always protects, whatever the weather may be, as rain or cold make little or no difference with it. The band need not be over an inch and a half wide and should be tightly bound by common wrapping twine, wrapped once or twice about it in the middle. In practice it will be found essential to have the bands this narrow of either wool or cotton, as the birds appreciate this material for a downy nest, and if it is not securely held by a cord, large chunks will be pulled out, leaving holes through which the cutworms can easily climb. If the wool is properly cared for, the same material may be used for bands for several years in succession, thus reducing the expense to a minimum.

DESTRUCTION OF THE CUTWORMS.

If to prevent the cutworms from reaching the tree tops were sufficient, the keeping of a wool band on the trunk would be enough; but every fruit grower should try to rid his fields of them. He should not only keep them from his trees, but should keep them from developing on other plants when they can not get into the tree tops. He must at least protect the trunks of his trees below the band or they may be girdled. The following methods will be found helpful:

CRUSHING BY HAND.—This was the method adopted by Mr. Rood, who found it a sure one, though rather laborious, as it kept one or more men

* Perhaps the statement should be made here that coal tar, if used at all on trees, should never be permitted to touch the bark, as a very small amount will leave a brown dead spot beneath. Young trees are very susceptible to injury by it.

at work all night. He would start out about ten o'clock with a lantern in one hand and a leather mitten on the other that crushed the cutworms without mercy. Usually each tree was visited about twice each night.

TRAPPING.—Around the base of each tree were placed three or four old boards or shingles, and a large share of the cutworms that escaped the crushing would hide under these traps for the day. Often hundreds would be found attached in a bunch to the under side of a single board, but it was either a rotten one or a rough one, for a smooth board for some reason was always avoided by the masses. Another thing worthy of note was that the white cutworm (*Carneades scandens*) was never taken under the traps. This species always came to the trees much later at night than the others and always came some distance from the trunk. The speckled and red cutworms are easily trapped, but they should be gathered early in the morning while it is yet cool, for as soon as the boards become heated, the cutworms will bury themselves in the soil where it is cooler and there is more moisture.

POISONED BRAN.—Bran, given a green tinge with Paris green, was dropped around the base of each tree as an experiment. The cutworms ate it readily both as they passed it in starting up the tree and as they came back hungry from their vain effort to get beyond the band. The next morning more than half of the cutworms were found hanging to the bark limp and dead, or in the same condition on the ground. In some cases 90 per cent were found dead. No doubt many that were not found, buried themselves in the soil and died there from the effects of the poison. Where much bran was eaten the poison acted very quickly. Bran with and without sweetening was tried, but the cutworms seemed to eat one kind as readily as the other. Possibly a supply of freshly poisoned bran will be desirable every few days.

POISONED TWIGS.—This experiment was made by dipping freshly cut twigs in Paris green water and standing them in the ground around the trunk where the cutworms could easily reach them near the band. This served as a good decoy and killed about the same number that the bran did. This makes more work than distributing the bran, but if one does not prune his orchard until this time, he can quite easily cut some fresh twigs every few days and apply poison to them.

SPRAYING THE TREES with the arsenites will be found to be of very little practical value. The leaves are still in the bud and the cutworm eats comparatively little of the outside and hence the poison is slow to act. Mr. Rood says of it, "I sprayed the trees twice, as it rained after the first application, and could not see that it did a particle of good. I had no idea that it would, but in my desperation I would try anything."

TO DETECT THE PRESENCE OF CLIMBING CUTWORMS.

It is not uncommon for people to have their fruit trees injured by climbing cutworms for some time or even for several seasons before they can ascertain what has done the injury. One may look carefully over the tree through the day for an insect, but there will be nothing to indicate the identity of the depredator except the injured buds. To one who has

had experience with this "thief in the night," the conspicuous absence is characteristic, for no other insect is likely to feed in this way and leave the tree during the day. Another method is to go out in the evening, if one suspects their presence, and listen for the chewing at the buds which is quite noticeable; or, better yet, put a band on the trunk of a few trees and examine below the bands for them by lantern light. If they have been troublesome in years past, or there is likelihood of their being present, the trees should by all means be protected against a sudden raid that might destroy a year's crop of fruit and endanger the life of the orchard as well.

PART II.—CONTROL OF THE COMMON GRANARY INSECTS.

Stored grain is liable to attack by numerous species of insects, and unless checked or killed they will soon destroy or greatly injure the grain in which they are working. Wheat is especially subject to attack by these insects, but ground feed and flour are often infested, and other stored grain, such as corn, oats and barley, may be injured by them.

The stored wheat is rapidly being reduced in quantity as prices advance, and there will probably be very little old wheat left in the bins when the new crop is harvested. There will be no better time to thoroughly renovate the granary or bins than at this time, and if insects have been numerous or are present, be sure that none of them are permitted to live to get at this season's crop of grain.

TO PROTECT AGAINST GRANARY INSECTS.

Our first axiom to observe is, *never put new grain into the granary on old grain.* If old grain remains, put it in a bin by itself, and entirely separate from the new. Where new wheat covers the old in a bin, there is a greater attraction to the insects which are sure to be present there, if anywhere in the granary. Usually the insects are already in the old wheat when the new is added and are ready to begin feeding on it at once. The work of the insects causes the new wheat to heat and this heat is favorable for the rapid development of the insects. When once a start is made, they are liable to soon over-run the granary.

The second point to remember is to *clean the bins and granary thoroughly each year before new grain is put in.* If insects are known to be present, or are suspected, the surest way is to fumigate with bisulphide of carbon or some such gas before the new grain is put in. It will cost less, and the work can be much more thorough before the grain is in. If no insects have been found, a thorough sweeping of the bins will be enough. The granary, and especially the bins, should be as free from dirt and old grain for a month before threshing as when first built. This will starve out the insects that otherwise might remain. Observation will show, if experience has not, that the farmer who cleans his granary thoroughly each season before the new grain comes, and who is careful not to leave grain scattered about through the year, is the one who never finds his stored grain molested by these pests. In our own State these insects are very seldom if ever carried into the granary in the grain from the threshing machine. They are either present before the grain is in the bins, or find it afterwards.

TO DESTROY INSECTS OF THE GRANARY.

There is only one practical method known by which we can rid the granary of the most of its insect pests after they are once well established in the grain, and that is by the use of bisulphide of carbon. This is a clear, almost colorless liquid, which is very rapidly converted into a gas on being exposed to the air. Owing to its being heavier than air it settles rapidly through the grain and quickly permeates the whole of it. *It is highly inflammable, and explosive when ignited, and care must be observed in keeping all light and fire from the gas, or near where it is confined.*

Local druggists rarely keep the bisulphide of carbon in stock as it so readily evaporates and the residue is then worthless, but probably your druggist would order it for you. If not, it can be ordered by yourself from some wholesale drug house in one of our larger cities. We order for our own use of Edward R. Taylor, Manufacturing Chemist, Cleveland, Ohio, as he makes a specialty of the bisulphide of carbon for such purposes. He sells it at the rate of 10 cents a pound in 50 pound (5 gallons) cases; in smaller quantities the price will be a trifle higher.

If insects are present in the grain and it is desired to treat them with the bisulphide of carbon, one of the first things to consider is whether the granary or the bin in which the grain is placed is comparatively tight. If it is very loose and open and cannot be tightly closed, it may be necessary to remove the grain to a tighter receptacle, as the gas will escape too quickly and the insects will merely be stupefied. Wheat bins and bins for ground feed can easily be made tight enough. If a cover is lacking, wet blankets thrown over the grain may serve as covers.

When the bins containing the grain are tight, one pound of the bisulphide is said to be enough for 100 bushels of grain. For a moderately tight bin, a pound or a pound and a half to each ton of grain is surer, and there is no danger of injury to the grain either for food or for seed when used at this rate. The liquid may be poured directly onto the grain by distributing it well over the surface. It may also be placed in open dishes or on an absorbent such as cotton batting, where it will evaporate more slowly and last longer. Where the grain is more than four or five feet deep in the bins, portions of the bisulphide should be put down near the middle of the grain and about every two or three feet apart. A piece of gas pipe will be suitable for this purpose. Inside the gas pipe should be a cylindrical stick that can be drawn out of the pipe as soon as it is pushed down into the grain as far as desired, and then the bisulphide can be poured down the gas pipe.

After the liquid has been applied, cover the grain as quickly as possible and leave it covered for twenty-four or thirty-six hours when it can be opened up and aired. The gas will very quickly mix with the air when the grain is exposed, so that in a few hours no odor can be detected. A second application may be found necessary in a month or two after the first is made. The bisulphide of carbon will kill mice and rats, that may be held in the bin, by inhaling the poisonous gas, and it is also injurious to man when inhaled in large quantities. There is no danger in its use if handled with judgment.

Millers and grain elevator men have found such a helping friend in bisulphide of carbon that they could scarcely do without it now. They suffer more from these pests than the farmer because they have to receive

grain from many different parties, any one of which may bring insects enough to infest the whole building.

THE COMMON GRAIN INSECTS.

Under this heading will be treated briefly the insects most commonly found in the granary and stored grain. Usually only one species will be found in the grain at once, but occasionally several species will be at work together.

THE SAW-TOOTHED GRAIN BEETLE.—(*Silvanus surinamensis* Linn.)

This little beetle is very small, only about one-tenth of an inch long, quite flat and slender and is of a dark chocolate brown color. Scarcely visible to the naked eye are little saw-like teeth on either side of the thorax. The beetles have been distributed in grain and allied products over almost the entire world. They live quite as readily in flour, bran, meal, screenings, breadstuffs and like materials as in grain. They breed very rapidly and one is not likely to notice so small an insect until they are abundant. A single generation develops inside of a month in warm weather, making at least five or six generations in a year. The larvæ are somewhat longer than the beetles, have only six legs, and are pale yellow with darker patches on the segments. They are active and move from one kernel to another eating them in part. This is the commonest species in our State, though the next species is nearly as common.

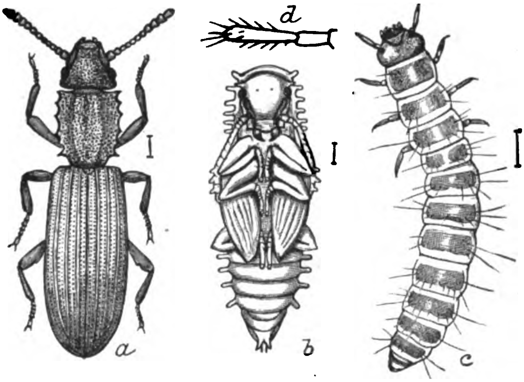

Fig. 9.—The saw-toothed grain beetle. *Silvanus surinamensis*: *a*, the beetle; *b*, pupa; *c*, larva—all much enlarged; *d*, antenna of larva still more enlarged (Div. of Entomology, Wash. D. C.).

THE GRANARY WEEVIL.—(*Calandra granaria* Linn.)

This is another cosmopolitan grain beetle, whose origin is probably traceable back of the Christian era into ancient Egypt or India. The species is not so omnivorous as the preceding one, living almost entirely upon grains and seeds, although it has occasionally been found in flour and ground mill-stuffs. The beetle has the long snout which characterizes it as the true weevil in distinction from other beetles. The beetles are smaller than a kernel of wheat and vary in color from a black to a uniform chestnut brown with a reddish cast. The larva lives inside the kernel of wheat while developing. It is white, plump, fleshy, without legs, and much shorter than the beetle. The cycle of life is not quite as rapid as in the preceding species and there are probably fewer generations in a year. The injury done is about the same as with the saw-toothed species.

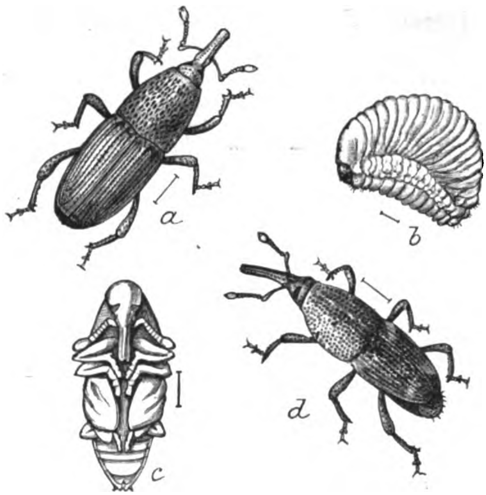

Fig. 10.—The granary weevil, *Calandra granaria*: *a*, beetle; *b*, larva; *c*, pupa; *d*, *Calandra oryza*, beetle—all enlarged (Div. of Entomology, Wash., D. C.).

Closely related to this weevil is the rice weevil, *Calandra oryza* and often the two are found at work together in the same grain. The rice weevil has four red spots on its wing covers, and is usually more common in tropical and sub-tropical climates. It chooses hulled rice for a diet when such can be found.

THE ANGOUMIS GRAIN MOTH.

The Angoumis moth, so named from Angoumis province, France, where it was very injurious, is much more common in the southern part

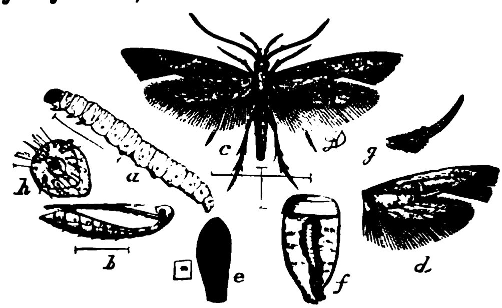

Fig. 11.—The angoumis grain moth, *Gelechia cerealella*; *a* larva; *b*, pupa; *c*, female moth; *e*, egg; *f*, kernel of corn opened, showing the larva feeding; *h*, anal segment of pupa —all enlarged except *f* (after Riley).

of our country than with us. It apparently does not breed on grain in the fields, as it is said to do farther south, and probably, if found in the granary, it has been introduced in seed or other grain brought from a more southern section. An instance of this we have found in our college exhibit of wheat at the world's fair. The pests were found in our grain on its return, and only by a thorough use of bisulphide of carbon were they eradicated. The usual attack of the species is upon corn and wheat, but other cereals are infested by it. The moth is very small, being about

half an inch across the expanded wings and with the body less than half that length. The larva lives inside the kernel, and, if corn, there are often several to each kernel.

FLOUR BEETLES.—(*Tribolium ferrugineum* and *T. confusum*.)

These two species of beetles are more particularly a menace to the miller, and the provision merchant who handles his products. The beetles

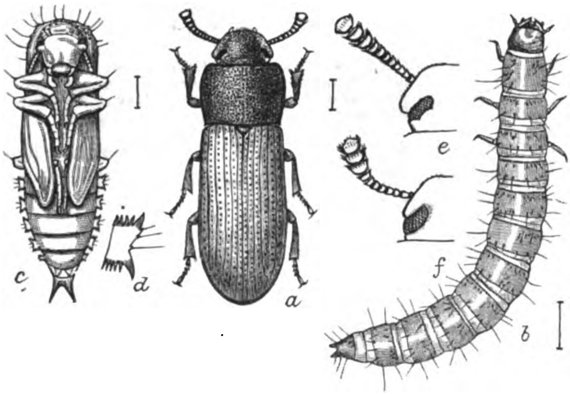

Fig. 12.—Flour beetle, *Tribolium confusum*; *a* beetle; *b*, larva; *c*, pupa—all enlarged; *d*, lateral lobe of abdomen of pupa; *e*, head of beetle, showing antenna; *f*, same of *Tribolium ferrugineum*—all greatly enlarged (Div. of Entomology, Wash., D. C.).

and their larvæ get into the flour and prepared grains for food and are so small that they are not easily seen. By the time the products reach the consumer, the insects have spoiled it for food and are often very abundant. The eggs are also deposited in the flour and they and the young larvæ are white and too minute to be detected. The beetles are deep red and about three-sixteenths of an inch long. The larvæ resemble those of the saw-toothed beetle considerably.

THE MEDITERRANEAN FLOUR MOTH.—(*Ephestia kuehniella* Zell.)

This moth has not, to our knowledge, made its appearance in the State yet, but it was introduced into Canada from Europe six years ago and is reported from New York, Colorado and some of the southern states, so that quite likely it will be found in our midst before many years. It has created much consternation in the millers at places where it has appeared and is often spoken of as the scourge of the flour mill. The caterpillars make a web tube in which they live and grow, and it is through the felting together of the flour by these webs that clogs the machinery and causes no end of vexatious delays and annoyances. Flour and meal are preferred as food, but when this is not to be found, almost any farinaceous material

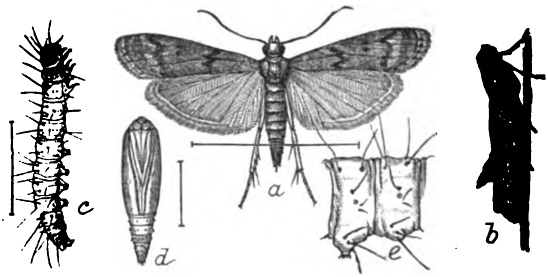

Fig. 13.—The Mediterranean flour moth, *Ephestia kuehniella; a* moth; *b*, moth with wings closed; *c*, larva; *d*, pupa—about twice natural size; *e*, abdominal segments of larva—more enlarged (Div. of Entomology, Wash., D. C.).

will be eaten. The primary wings of the moth are a leaden gray with irregular blackish cross lines. With wings spread the moth measures a little less than an inch from tip to tip of wings.

THE MEAL SNOUT-MOTH.—(*Pyralis farinalis* Linn.)

Meal and other ground products from the mill, after standing awhile, will often contain little masses woven together by web-like threads. There are several species that spin these webs for a home in which they live and transform. This species is most commonly found in old meal or ground feed containing meal. They often infest mills and hide in crevices where it is difficult to reach them. The three stages are given natural size in the cut.

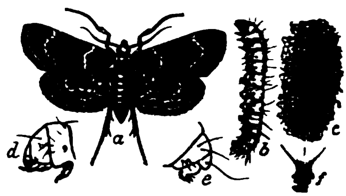

Fig. 14.—The meal snout-moth *Pyralis farinalis; a*, moth; *b*, larva; *c*, chrysalis—all natural size; *d*, head of larva; *e*, terminal segment of the same; *f*, tip of pupa—enlarged (Div. of Entomology, Wash., D. C.).

THE INDIAN-MEAL MOTH.—(*Plodia interpunctella* Huebn.)

This is a species that is even more injurious than the preceding as it is more widely distributed and injures a greater variety of edibles. It not only feeds on grain, both whole and ground, but on various kinds of dried fruits, seeds, nuts, roots and herbs, and is also said to use condiments freely and to feed on sugar, jellies and yeast cakes for a greater variety. It builds a web the same as the meal snout-moth. The moth is much smaller than the snout-moth and the wings are narrow. It passes through its transformations very rapidly in warm weather, making perhaps six or seven generations in a year.

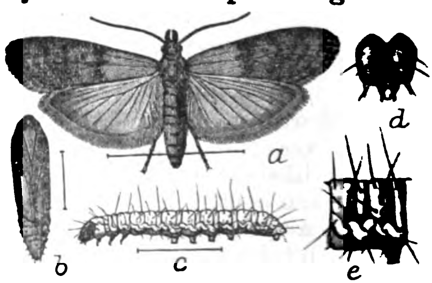

Fig. 15.—The Indian-meal moth, *Plodia interpunctella; a*, moth; *b*, chrysalis; *c*, caterpillar—twice natural size; *d*, head, and *e*, first abdominal segment of caterpillar—much more enlarged (Div. of Entomology, Wash., D. C.).

THE COMMON MEAL-WORM.—(*Tenebrio molitor* Linn.)

Closely related to the flour beetles, and resembling them closely in appearance, except much larger, is this common meal-worm which infests the meal and bran chests from which the farmer feeds his stock. The species very rarely attack the entire grain, but will eat almost any kind of ground feed. The larvæ are more than an inch in length when full grown, are brownish yellow with darker spots on the segments and have much the appearance of wire worms. The beetles are about half an inch long and are dark brown or black.

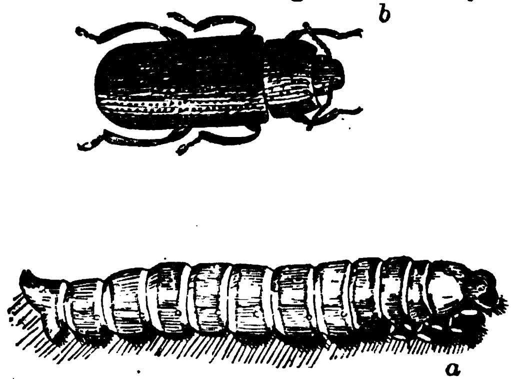

Fig. 16.—The common meal-worm, *Tenebrio molitor*: *a*, larva; *b*, beetle—twice natural size.

THE CADELLE.—(*Tenebrioides mauritanicus* Linn.)

The French "cadelle" is a common granary insect in Europe and we occasionally find it in the same roll here, although rarely in large numbers. Last autumn, Mr. H. D. Hobbs, of Williamston, Mich., found the larvæ at work in a barrel of beans in his grocery and sent samples of the beans and larvæ. There was very good evidence that they had been feeding on the beans. They were placed in a breeding jar with the beans, but the larvæ gradually disappeared. They are predaceous and quite as often feed upon other insects and even upon each other as upon stored grain, and this proved to be the case in this instance.

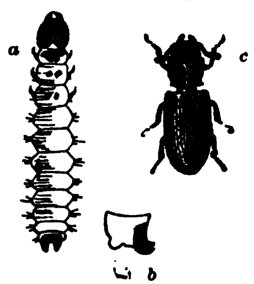

Fig. 17.—The cadelle, *Tenebrioides mauritanicus*: *a*, larva; *b*, side view of apical segment; *c*, beetle—twice natural size.

PART III.—CARPET BEETLES.

The good housewife is still forced to fight the carpet beetles or to abandon the use of carpets. The people of the upper peninsula and upper part of the lower peninsula may congratulate themselves that they are still practically without experience as to what the carpet beetle is, though quite possibly their immunity from its attack will last but a few seasons more. From the southern and central part of the State come repeated calls for assistance until it seems best to wait no longer even if we are not sure yet that we have an ideal remedy in every respect to give.

There is strong demand for a good remedy, and there are many products put upon the market to meet this demand. Some of these remedies have merit, but such as we have tested include some one of the substances to which reference will be made later and which can be procured cheaper and applied as well where taken separately and not in combination with half a dozen other ingredients which are of little or no value as insecticides in this instance at least. I refer particularly to such substances as pepper, sage, mustard, hellebore, snuff, Persian insect powder, tobacco, etc., which are used as powders alone or in combination with something else. Some of these materials will stupefy the larvæ, but none of them will kill. All arsenical preparations should be avoided as dangerous.

At least a few of these combinations are utterly worthless. One instance will illustrate this point. About a year ago an article started from one of our leading Michigan dailies and freely circulated through the others. It is under the heading "HERE'S A GOOD THING," and reads as follows:

"A lady reader of the —— claims to have tried the following recipe, and she says she knows from her experience that it is sure death to the carpet bug:

"One ounce of alum, one ounce chloride zinc, three ounces of salt. Mix with one quart of water and let stand over night in a covered vessel. In the morning pour it carefully into another vessel, so that all sediment may be left behind. Dilute this with two quarts of water and apply by sprinkling the edges of the carpet for the distance of a foot from the wall. This is all that is necessary. They will leave boxes, bedding, and any other resort which has been sprinkled with the solution, on the shortest possible notice, and nothing will be injured in texture or color."

Inside of a week after the appearance of this article the remedy was given a thorough trial by the writer. On one side of the room the carpet was soaked as recommended, and on the other side it was taken up and rolled over, leaving a large number of little hairy larvæ exposed on the floor where they were thoroughly wetted, but there was no injury whatever, except that the carpet was left in a condition to gather moisture as though salted. The little hairy fellows were

even put into the solution and made to swim and soak in it for half an hour without killing them.

The burning of sulphur in the rooms was thoroughly tried by one of our Lansing ladies, but with no success.

Before entering upon a campaign against the carpet beetles, it is desirable to learn something of their habits. Two distinct species have been found in the State. The most common one is the imported carpet beetle, known scientifically by the name *Anthrenus scrophulariæ*, and commonly known as the "buffalo moth," "carpet beetle," and often, though incorrectly, as the "carpet bug." The other one is *Attagenus piceus*, which we may term, to distinguish it from the other species, the bushy-tipped moth. We have good reason to believe that there is a third species *Nitidula bipustulata*, but have no definite proof at the present writing.

THE BUFFALO MOTH.

The larva.—The little hairy larvæ are quite appropriately named buffalo moths from their general resemblance to the shaggy haired buffalo. While young they are so nearly covered with long blackish hairs that the

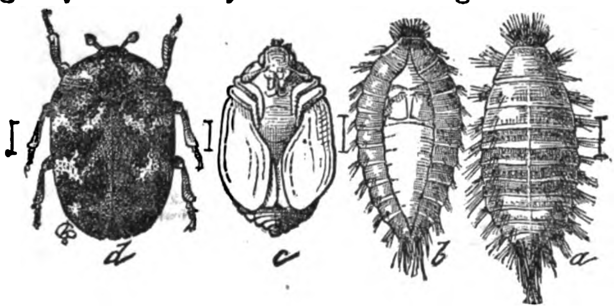

Fig. 18.—The buffalo carpet moth, *Anthrenus scrophulariæ* Linn: *a*, dorsal view of larva; *b*, ventral view of same; *c*, pupa; *d*, beetle (after Riley).

body can hardly be seen. Their movement is very quick and spasmodic, yet no legs can be seen as they are short and entirely covered. The body is oval and of a yellowish red color. The coat of bristly hairs, which vary in color from dark brown to black, are longer at the sides than on the back and somewhat tufted, and behind there are three long distinct tufts. As the larvæ become older and larger, more of the body shows, but all of them are more hairy than is represented in the figure. They grow to be nearly a quarter of an inch in length, and as they grow they shed their larval skin about half a dozen times. One often finds these skins along with the larvæ, and without close inspection, might be led to think there were many more of the moths at work on a carpet than there really are.

The larvæ are retiring and keep in hiding when possible. They like to live in a crack of the floor, particularly if it is a dirty one where they can quickly hide, and will feed on the carpet along this crevice until full grown. More often they will be found near or around the border of the carpet, and, as soon as exposed to the light or disturbed, will quickly hide in the space between the baseboard and the floor, if such a crevice can be found. Quite often in feeding on carpets a larva will eat at a single thread and follow it for some distance. When food is plentiful the

larvæ grow rapidly, but their tenacity of life is great as they have been known to live without food, except the skins which they shed, for a month or two and still survive. It is in this larval stage and this only that the harm is done to the carpets.

The pupa.—When the larva is full grown, it hides in some crevice and tansforms inside the shell made by its own skin. After a time this larval skin splits open along the back, revealing the pupa from which the imago, or beetle, emerges a little later.

The beetle is nearly as broad as long, and is small enough to crawl through the meshes in our common gauze window screens. It is black, prettily mottled and specked with white and with a more or less distinct median red stripe down the back. Light attracts the bettles and they may often be found on the window panes in the spring and fall. The most of their life is spent out of doors, and they are in the house only for the purpose of depositing their eggs on the carpets. They are lovers of flowers, particularly of the family *Scrophulariæ*, which led Linnæus to name them after this family of flowers. They may also be found on sunflowers and asters in the autumn, and I have seen them so plentiful in the spring on the blossoms of a choke cherry tree on our college grounds that they could be counted by the hundred.

In all probability a large share of these beetles were not bred from carpets or any fabric. The family *Dermestidæ*, to which our buffalo moth belongs, is well known to feed chiefly upon dried animal substances, and quite likely we shall find that many of the larvæ maintain themselves in this way. Mr. Percy Selous, of Greenville, Michigan, writes me that he has reared them in this way along with the bacon beetles, and we have occasionally found them as a museum pest on our mounted insects.

LIFE HISTORY.

The complete life history of the buffalo moth is not yet known, but, as near as we can find, there is but one brood of them each year, except in houses and rooms that are heated during the winter, when growth continues throughout the year and there are probably several generations. Where rooms are not heated in winter, the larvæ vary much in size and no regular development can be traced. The eggs are deposited on the carpets, probably in the fall and spring, perhaps before the beetles leave the house. They soon hatch into young larvæ which feed on the carpets through the summer season and change to the pupa stage in the autumn and again to the beetle stage from the pupa.

EARLY HISTORY AND PRESENT DISTRIBUTION.

The buffalo moth received its scientific name, *Anthrenus scrophulariæ*, in Europe in 1758. It is known as "the common flower beetle" and not as a carpet pest as it has become in this country since it has found its way here. In 1850 a variety was found on the Pacific coast by Dr. Le Conte, but only within the past few years has it been known as a carpet destroyer there. Its real destructive work dates from 1872 in Buffalo and Boston, but since that time it has spread over most of the northern part of the United States. Mr. L. O. Howard, of the entomological department at Washington, D. C., says that this species does not occur there nor in Baltimore, and is not common in Philadelphia. The northern

limit of the species in our own State seems so far to be in the upper part of the lower peninsula, and with nothing, to my knowledge, reported from the Canadas across from this upper section.

THE BUSHY-TIPPED MOTH.

This species was first reported to us by Mr. Selous, of Greenville, who found the larvæ at work, and, putting them in a little wooden box, reared the beetles last spring. Last season the same species was found at work in one of our college residences. It and the buffalo moth were both at work on the carpets in about equal numbers, and their united attack was anything but pleasant to the lady of the house. Mr. Howard says that this species takes the place of the buffalo moth in Washington, although not yet a serious pest there. Quite likely when the species is better known we shall find it a co-worker in many places with the buffalo moth.

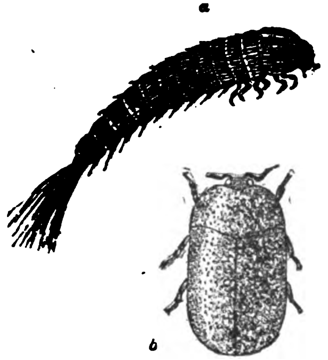

Fig. 19.—The bushy-tipped carpet moth, *Attagenus piceus* Oliv.*: *a*, larva; *b*, beetle—five times natural size.

APPEARANCE.

This species can at once be distinguished from the other, either in the larval or beetle stage. The larvæ are larger, more slender, taper to a point behind and have a tuft of long coarse hairs on the terminal segment only. The rest of the body is sparsely covered with very short hairs which protrude somewhat beyond each segment. In color they vary from a reddish to a yellowish brown, with whitish rings at the base and apex of each segment. The beetles are also somewhat larger than those of the buffalo moth, more flat and shining uniform reddish black with little punctures over the wing covers and thorax

HABITS.

In habits, as far as we have been able to ascertain, there appears to be little difference from those of the buffalo moth. There seems to be but one brood a year, the larvæ remaining over winter and pupating the following spring. The larvæ are also more uniform in size.

The food habits of the species seems to be quite varied. Besides feeding on carpets and woolens, it has been bred on dried animal tissues. Mr. Chittenden, of the department of Washington, D. C., says that he has confined both the beetles and their progeny to a diet of flour and meal and found that they thrived well on it. He also found the species breeding in timothy seed and often found the beetle in the granary along with the more common grain insects.

The species has been known in America since 1806, but never in the role of a carpet enemy until within the last two or three years.

* The larva has not yet been reared by us, but was kindly determined for us at Washington, D. C.

THE CONQUEST.

Under this heading will be given the best methods of subjugating the carpet moths, as learned from our own experiments and the experience of others who have had ample opportunity to test the various remedies. No attempt will be made to give all the known remedies, but only such as are known to be the most valuable of those tested.

THE USE OF REPELLANTS.

Very little if anything has been done by our entomological experimenters in searching for a useful repellant that will keep the female beetle from the carpet as she comes to deposit her eggs. Such a substance may not be possible, but, if we can succeed in finding some harmless repellant, it will be more satisfactory than all the remedies for killing the larvæ that can ever be suggested.

The idea of a repellant and the successful use for some time of the expensive cedar chest against the clothes moth, suggested to my mind about a year ago the trial of cedar oil in this role. A small dry goods box was procured for the experiment, and carpet beetles with larvæ of both species were placed in the box along with some bits of cloth for the larvæ to feed upon. In a few days after all had become accustomed to the new surroundings, perhaps a quarter of a teaspoonful of the oil was blown in a spray across one end of the box, taking care not to hit any of the cloth which was in the opposite end. The odor disseminated very quickly and the effect was almost magical. Even the larvæ quickly left the cloth in which they were hiding and crawled out over the edge of the box to the fresh air or into some crevice opening to the outside. Repeated experiments proved them to always be susceptible to the oil which apparently affects their breathing. A spray directed upon the larvæ will not kill them until they are well saturated with it. The beetles apparently have much less power of resistance against the oil, and are more easily killed.

We are sorry to say that we were unable to give this experiment a fair trial in a large room and its effect may not be as decided there as in a smaller space. The cedar oil costs but ten cents an ounce and is well worth a trial at least. Chambers and rooms that are little used are the most liable to attack, and we would suggest that in such rooms at house cleaning time the floor should be sprinkled or, better yet, sprayed, and very thoroughly so close to the base-board, just before the carpet is replaced on the floor. There is no danger in using too much of the oil, though perhaps from two to four ounces will be the most desirable amount. The cedar wood odor is a pleasant one to most people and harmful to none. My experimental box still retains a distinct odor of the cedar oil, though no more has been used in it since the experiments.

AIDS IN PROTECTION.

From the habits of the larvæ, of which we have already learned, several aids suggest themselves which have proven quite helpful in keeping the larvæ from their natural haunts and in finding them and eradicating them much more quickly than otherwise could be done. They may be enumerated as follows:

(*a*) Have a tight quarter-round put on next to the base-board so that there will remain no cracks in which the larvæ can hide or secrete themselves to pupate.

(*b*) Clean all cracks in the floor thoroughly and then fill them with putty, or what is nearly as good, plaster of Paris. These crevices between the boards are excellent breeding places for the larvæ even though great care is used in cleaning them at house cleaning time.

(*c*) If the floor is not smooth and polished, and if the cedar oil does not prove to be what we hope for it, an excellent plan is to paint the floor. This fills up many little cavities that otherwise might be a lurking place of the foe.

(*d*) Many recommend a strip of tarred roofing paper around the room beneath the border of the carpet and affirm that the odor is a repellant. We have not tried it, but presume it to be an aid.

(*e*) Never leave old garments or woolens in an attic or other little used room, as such articles will surely attract the carpet beetles to the house and will make an excellent breeding and distributing location for them.

DESTROYING THE MOTHS.

(*a*) When the carpet is infested, it should be taken up, hung out of doors on a line, in the sunshine if possible, and after a thorough beating, should be saturated with gasoline to kill all possible life remaining. The carpet should then be left until the gasoline has entirely evaporated. It should be hung at least a rod or two from the house to prevent the possibility of the larvæ that are beaten out ever re-entering the house to injure carpets again.

(*b*) If the floor has not been prepared as given under "aids," it should be well soaked in kerosene oil, or at least in gasoline, after the filth has been removed and burned. If it has been prepared carefully as above, the sweepings should be burned and any larvæ that may remain can easily be detected and despatched in any way most desirable. Kerosene is better for the floor than gasoline as it does not evaporate so quickly and its effect will be more certain. There will be no oil stain to the carpet if the floor is left exposed for a few days as it should be in such cases.

(*c*) If the larvæ can easily pass from one room to another it would be well to clean and treat all such rooms before putting the carpet back in any one of them; otherwise the work might be of little avail because of neglect in this one point.

(*d*) Where the larvæ are at work only in a small spot in the carpet, and the taking of the carpet up is not desirable, they may be killed with steam by spreading a wet cloth over the spot and ironing it with a hot flat-iron.

(*e*) Whenever the beetles are found on the window panes or sills, they should by all means be killed.

HOW TO ENTIRELY AVOID THE CARPET BEETLES.

As was stated before, our carpet beetles are unknown as such in Europe from whence they came, and it has been suggested many times that the reason of this is because there are so few carpets in that country. Should we choose to abandon our carpets and substitute polished or painted floors covered in part with rugs and mats that can be often shook and beaten, the carpet moths would soon be a foe of the past.

The carpet which is most apt to be eaten is the one put down in some upstairs room which is seldom used and, if some desirable substitute could be made in such rooms, the rest of the house would be comparatively free from attack. Japanese matting is coming into quite general use instead of carpets in the warmer portions of our country, and to some extent in our own vicinity. A carpet with a two-foot strip of matting for an outer border has been used by some with good success. Others have painted a border and left the carpet loose, that it might frequently be taken up and shaken.

CLOTHES MOTHS.

In a general way the clothes moths are quite similar to the carpet beetles in their destructive work. They differ from them in that they seldom if ever attack carpets that are on the floor, but will attack carpets, furs, clothing, or any kind of woolens that are stored away and only used occasionally. They prefer seclusion and absence of bright light for their work, and bureau drawers, chests and clothes presses, in which such clothing is usually kept, make them an ideal place in which to live undisturbed.

In Michigan there are two species of the clothes moth, *Tinea biselliella* and *Tinea pellionella*, both of which are common and about equally destructive. Neither of these species is a native of the United States. They are of European origin and have been brought here in clothing as they have been carried to all other parts of the world where woolens are worn, until they are now known over nearly the entire globe as "clothes moths." Dr. Riley refers to a third species, *Tinea tapetzella*, which has the same habit, but this species is less common and need not be more than referred to here as it probably does not occur in our State.

TINEA BISELLIELLA.

Through June and the last of May, and again in August and September, minute buff-colored moths may be detected flitting around the rooms of the house. They are most active about dusk or in the evening when a room is not brightly lighted. They are probably even more active in entire darkness, and it is probably at this time that the eggs are deposited on garments by the females. The moths are so minute that it is difficult to keep chests or other receptacles in which clothing is stored, tight enough to exclude them. The moths with their wings spread do not measure over three-eighths of an inch from tip to tip and the body is slender and not much more than an eighth of an inch long. My experience has been that people do not suspect trouble from so small a moth, or even notice it, but almost invariably condemn the large night-flying cutworm moths as the parents of the household pest. In depositing her eggs, the female usually works her way deeply into the folds of the gar-

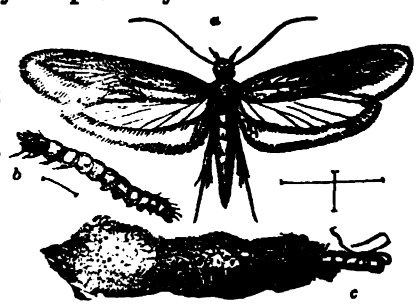

Fig. 20.—The clothes moth, *Tinea biselliella* Hum.: *a*, adult; *b*, larva; *c*, cocoon and empty pupa skin—all much enlarged (after Riley).

ments or along the seams where the edges are folded over. From these eggs come the young white soft-bodied larvæ that gnaw the clothing. They cut and injure much more of the garment than is needed for food, and some of this refuse is drawn around them to afford a better protection. When full grown, the larva remains where it has been feeding and constructs a cocoon of the loose fragments around it, woven by silken threads. In this cocoon it completes its transformation and appears as a moth about two or three weeks later.

Clothing is what the larvæ most generally feed on, but Dr. Riley reports an instance where he knew of a large stock of feather dusters that were completely ruined by them, and he has often had camel's hair brushes destroyed by them when lying loose in drawers. In the spring of 1891, our attention was called to a pair of rubber boots that had been made unfit for wear by the felt lining being so badly eaten by the larvæ. From this felt we reared two broods through the season, the moths of the first brood appearing mostly in early June and those of the second in August and September, and even up to the middle of October. In furnace or steam heated houses, the species is probably active the year round.

TINEA PELLIONELLA.

The moth of this species is usually somewhat larger than the preceding one and is more brownish, with a sprinkling of small dusky spots over the brown wings. There is apparently but a single brood each season of this

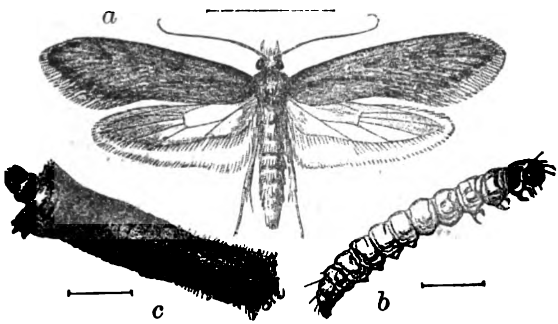

Fig. 21.—The clothes moth, *Tinea pellionella* Linn.: *a*, adult moth; *b*, larva: *c*, larva in its case—much enlarged (after Riley).

species. The moths appear mostly through May and June, and the larvæ develop by autumn ready to hibernate and transform to the pupa in early spring. The larva resembles that of the preceding species, but differs somewhat in habits. Instead of constructing a gallery of loose bits of cloth bound by a few threads, this species weaves a compact silk-lined gallery, or case, in which it lives, and increases the case in size as it grows. When full grown the larva does not leave the case, but often carries the case with it to some more secluded place. Dr. Riley gives an instance where he has seen these larvæ "drag their heavy cases up a 15-foot wall and fasten them in the angle of the cornice of the ceiling." When the case is thus located, the ends are carefully sealed with silken threads and in this snug retreat the transformation is continued to completion.

MEANS OF PROTECTION.

It is much easier, we find, to keep a house free from clothes moths than to rid the house of them after they are once thoroughly established. There are few dwellings which have not some dark clothes press in which woolens are left exposed during the summer. Often old clothing or woolen rags are thrown into a little used attic and thoughtlessly left. Upholstered furniture not in use is often carried to the same general reception room for cast away articles. All of these articles and many more of a like nature, such as feathers and furs, are very attractive to these little moths and make a breeding place for them that is sure to bring annoyance and grief to the house matron if such practice is continued. The first item then to remember is to avoid unnecessary exposure of anything that will attract the moths and on which their young can feed.

Clothing, including furs, to be stored in the wardrobe during the summer, can be kept entirely exempt from attack if put into new flour sacks, linen sacks, or something of that nature, and tightly tied so that a moth cannot enter at the mouth. Chests serve the same purpose when tight enough to prevent the moths from entering.

Garments to be kept free from the moth entirely by isolation, as mentioned in the last paragraph, must not be left exposed for a month or two after the wearer has discarded them before they are packed away, as the moths are most active in May and June and are the most likely to deposit their eggs on these garments before they are safely stored. They should be put in safe keeping without delay as soon as doffed and cleaned.

Various repellants, such as camphor, moth balls of naphthaline, snuff, tobacco and similar substances are in quite general use and have usually given fair satisfaction. Cedar chests are well known to give protection against the moths, but they are quite expensive. In all probability cedar oil, as spoken of under the carpet beetles, will prove to be an excellent repellant in a wardrobe, bureau or chest, when sprinked over the wood work occasionally. It seems superior to all other repellants tried by myself and quite likely will be sufficient to keep all moths away.

Where the larvæ of the clothes moth are known to be at work, there is probably no better or simpler method of dealing with them than to apply a liberal quantity of benzine or gasoline to the garments on which they are feeding. Then the garments should be hung out of doors in the sunshine and thoroughly aired. There may still be eggs or larvæ that have escaped the first application, and a second a week or two later is desirable to make the work certain. Other garments of the same wardrobe are likely to be infested and should at least be inspected in bright light and watched for a few weeks. The room should also be sprayed that the work may be complete. What has been said of careful thorough work regarding the carpet beetle is also of equal importance in dealing with the clothes moths.

Linen and cotton goods are not attacked by the moths. Neither will garments that are in frequent use be attacked. Upholstery of furniture, linings and trappings in carriages and similar material remain free from attack by use and plenty of sunshine.

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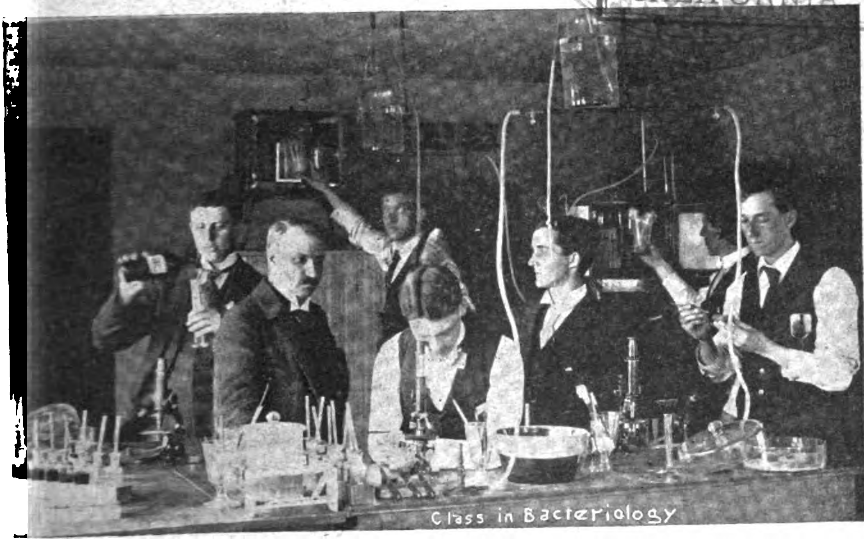

Class in Bacteriology

133. Tuberculosis

134. A Preliminary Bulletin on Pasteurization of Milk

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BULLETINS 133, 134 JUNE, 1896

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133 TUBERCULOSIS
Veterinary Department

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Farm Department

By E. A. A. GRANGE and CLINTON D. SMITH

AGRICULTURAL COLLEGE, MICHIGAN
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TUBERCULOSIS IN CATTLE.

BY E. A. A. GRANGE, PROFESSOR VETERINARY SCIENCE.

During the past few years the subject of tuberculosis has been so often brought before the public, especially in connection with dairy cattle, that enquiries are continually coming to this department, for information concerning its causes and symptoms, as well as other phases of the disease. To meet the above mentioned demands it has been deemed advisable to issue a bulletin upon the scourge.

The writer's experience in this State with Koch's lymph or tuberculin, as it is now generally called, as a diagnostic agent will also be noticed; and the various lines of investigation or experiment now in progress here, with a portion of the College Experiment Station herd will at the same time be briefly described.

TUBERCULOSIS may be defined to be a specific communicable disease, due it is believed to the presence of microscopical parasites in the tissues of the afflicted animal, giving rise to the formation of tubercles or round eminences which vary in size from a millet seed upwards.

The complaint is known under a variety of synonyms each having some relation to the symptoms or other phenomena of the disease. The ancient name of *Phthisis* was given to it by the Greeks and in their language means "wasting, or consumption," and even today in our own, the term consumption is frequently used; thus we have pulmonary consumption, consumption of the bowels, and so on, and so on; the more classical however using the terms pulmonary phthisis, or tabes (L. wasting) mesenterica as the case may be. In Germany the disease is often spoken of as *perlsucht*, or as we have it, pearl disease of cattle, which name is due to the formation in different parts of the animal economy of little nodules or tubercles resembling pearls.

While exception may be taken to the general term *tuberculosis* for this disease, on account of its being for the most part anatomical, and not comprehending the cause of the disorder, yet it is the word which is being used more and more every day, and no doubt will become more familiar to us from usage as time wears on. When the disease confines its ravages to the skin it is called *lupus*.

HISTORICAL SKETCH.

It is doubtful if there is any disease which has a more interesting history than the one in question, indeed it often becomes romantic, for in its subtle manner it strikes down kings, princes, and statesmen, rich and poor, in the same merciless manner; while it invades the economy of the high class $20,000 cow, and wipes her out, with as much certainty as it does the $20 scrub.

The date or time when this disease made its first appearance upon the earth is wrapped in considerable obscurity. The bacteriologist contends that long before the existence of man the special bacterium which causes it led a saprophytic existence (lived beyond or outside of the animal economy) but through environment it has become a parasitic microbe (one which lives inside, or upon the animal economy). When, it may be asked, did this change from the saprophytic to the parasitic condition of the microbe occur? Well, without presuming to answer the question let me call the reader's attention to the second Book of Moses called Exodus, supposed to have been written about 1,600 years before the Christian era, and there we find in chapter ix, verses 1-16, a grevious murrain is described as affecting cattle. Now the word murrain is derived from a Latin word meaning to die, and by some high authorities is defined as an infectious disease of cattle.

In the 9th and 10th verses of the same chapter we are told that the ashes which he (Moses) sprinkled heavenward before Pharaoh, became a boil breaking forth with blains upon man and beast. The description contained in these holy writings suggest the thought, that these ashes may have contained some of the saprophytic germs and that, at that time they may have been converted from their harmless non-pathogenic condition, to the baneful, pathogenic or disease producing bacteria which they are today.

The disease has been noticed by veterinary writers including Columella, who flourished about 1,800 years ago, and others before him. down to our own day. Many were the reasons which were given for its appearance in the tissues, but they one and all failed to explain its existence in a satisfactory manner until the discovery of the true cause of the disease which was announced to the scientific world by the far famed Prof. Robert Koch, in March, 1882, at Berlin, Germany, since which time his classical treatise upon the "Ætiology of Tuberculosis" has been translated into our own language, through meritorious efforts of the Massachusetts State Veterinary Association. In this volume it is clearly shown that the disease is due to the presence of a minute rod. which gains access to the economy of its host, in one way or another. and is now familiarly known as the *Koch bacillus of tuberculosis*. The disease was first recognized as being of a contagious or infectious nature as far back as 1761 by Morgagni, but the more learned Jews must have had some suspicion of its contagious nature long before this time, for we find as early as the year 1135 A. D., that they rejected animals having internal ulcers, contending that they were not fit for food. While many of these ulcers may not have been due to tuberculosis, yet the practice in a general way must be commended, and it is pleasing to note the care which is taken today in this State in the Jewish slaughter houses

with regard to the examination of the lungs and other parts for diseased conditions. It is only within the last half of the last decade that Tuberculosis has come to be generally regarded as a contagious or infectious disease by health authorities in many parts of the world.

DISSEMINATION OF THE VIRUS.

In the present light of our knowledge of cause of this disease it appears evident that the sources of infection demand close attention, for how can we ever hope to fulfill the prophesy of that savant Pasteur, who has immortalized himself by his work, when he says in his discussions upon the cause of disease: "Man has it in his power to cause parasitic disease to disappear off the surface of the globe, if, as we firmly believe, the doctrine of spontaneous generation is a delusion," if we do not block the avenues, through which the virus gains access to the economy?

The avenues of infection open from various sources. First amongst them let me speak of the sanitary surroundings of some of our most carefully guarded stock, for though singular as it may appear, it is amongst this class of animals that we oftenest meet with the disease—why? well they are housed in the most comfortable quarters, too often without sufficient ventilation or sunlight, and even when ventilation is permitted in all reasonable quantity, the greatest care is taken to prevent anything like a draught, the fresh air is required to come in on its tip toes, as it were, keep very quiet, and make its exit as quietly as it came in. As for the sunlight, it is probable that it never gets into many cow stables directly, especially in those cases where the compartment is on the north side of the building. When the stable is more favorably situated, the windows may be small, and too often covered with cobwebs or dust or both. In fact as far as our experience has gone, pure sunlight in a cow stable is the last thing thought of from a sanitary point of view.

It is well known to bacteriologists that direct sunlight has a most baneful effect upon the bacillus of tuberculosis, destroying it in a short time, and even diffuse light will in time work similar results.

Place a cow in the early stage of tuberculosis in a stable, poorly lighted and indifferently ventilated, with 20, say healthy cows, the sick cow invariably gets worse, and spreads the disease to some of the others, by scattering the contagious matter, right and left, with her excretions. It may take some time to develop the complaint in this way, but in the long winter months of northern latitudes where valuable cattle are often housed, perhaps more than is good for them, there will be ample time as well as opportunity to spread the disease. Environment as an avenue of infection may, in due course, be blocked by observing strict hygienic principles, and separating healthy from unhealthy animals.

MANIPULATION OF THE FOOD AN AVENUE OF INFECTION.

In some well regulated establishments the food is occasionally handled in such a manner that it becomes an excellent vehicle for disseminating the disease, to wit: the cattle are all fed a certain amount of a certain ration at stated periods every day, and it often happens that one or two

of them (varying as to individuals from day to day) will not eat it all up; that which remains is taken from the mangers at a certain time after feeding, and placed in a pile, where it is mixed with the next general ration to be fed out again at the next feeding hour, indiscriminately to one or all of the animals, and thus the disease is handed in the most unsuspected manner from one cow to another. In this way valuable cows may be literally killed through misguided economy, by being required to eat such food as has been showered upon, with disease bearing sputum from their afflicted stable mates, and from one cow it spreads, gradually through a large percentage of, if not the entire herd.

A broad avenue of infection in the young especially, is the milk, as this may contain the germs of the disease in considerable numbers, and yet the udder not be affected. It is perhaps unfortunate that in the early stage of the bacteriological investigations of this disease, it was thought that as long as the udder was healthy the milk was safe, but we have too much experimental evidence at this time, showing the contrary to be true, to permit our using the milk from afflicted cattle without first Pasteurizing or sterilizing it. Cattle licking their diseased stable mates are liable to contract the disorder, while the inhalation of dust from a stable floor bespattered with the sputum from a diseased animal, or dried excreta from the bowels or bladder, might be dangerous. Numerous intelligent breeders believe that bovine tuberculosis is hereditary, and even many scientists in their writings are not at all clear upon this phase of the disease. The confusion of the terms *hereditary* and *congenital* are no doubt responsible for our being sometimes misled as to these avenues of transmission. Even Fraenkel (p. 245), in his classical text book upon bacteriology, if he is correctly translated by Linsley, mixes these terms in such a manner that if we are to accept his statements the germ theory of bovine tuberculosis is undermined and to use his own words "at once falls to the ground." It is true that the author does not admit that tuberculosis may be an inherited disease, on the contrary he insists that it is not, though he does not undertake to prove it, in his description of the disease to which we have taken the liberty of referring.

For my own part I believe that tuberculosis never was hereditary, is not now, and never will be. To demonstrate the grounds for this position we must first of all draw sharp lines between the meanings of the words, *congenital* and *hereditary*, then we must go back to the very derivations of the terms, and trace them step by step, until figuratively speaking, we find the disease manifesting itself through symptoms in the living animal. The word *congenital* according to the Etymological Dictionary by the Rev. W. W. Skeat, professor of Anglo-Saxon, in the University of Cambridge, England, is derived from the Latin word *congenitus*, meaning, *born with*. According to the Medical Dictionary of Dunglison, M. D., LL. D., late professor of medicine and medical jurisprudence in the Jefferson Medical College of Philadelphia, it means *begotten with*, and here let me say that some importance of passing interest may be attached to the different meanings of the word, given to it by the different authors. When, may I ask, is a creature begotten? or when is it born? If the solution of the problem were left to the writer, it would be said that a creature is begotten as soon as the spermatozoon of the male unites with the ovum of the female, and the process of repro-

duction commences; while the creature is born when it is brought into the outside world and breathes free oxygen; when in the language of the bacteriologist it becomes an obligative aërobe.

Now we may trace congenital tuberculosis in the mother to the ovaries and in the sire to the testes. The ovaries being the seat of the disease it is not difficult to imagine the minute bacillus insinuating itself into the Graafian vesicle, and when the latter bursts at the time of menstruation, the germ may easily be carried with the ovum into the fallopian tube, or womb itself; and in one or other of those places, and in company with the ovum, unites with a spermatozoon from the male, and if conditions are favorable the germ multiplies, while the new creature steadily grows, so that when the being is born it may at that time be already affected with the disease. That form of the complaint we interpret as congenital tuberculosis coming from the mother. On the other hand the testes of the male may be affected with the disease, so that when the exceedingly minute bacilli of tuberculosis are liberated in them they may readily be carried by the spermatozoa, which are giants in comparative size, into the generative organs of the female, and there meeting with the ovule, the new (begotten) creature is inoculated, this time, though, from the male fruit of impregnation; constituting congenital tuberculosis coming from the sire. In this case the mother may give birth to her offspring laden with the germs of disease, without ever having a vestige of the same complaint herself. We may even go beyond this, and easily trace bovine tuberculosis, or rather the germ of it, from the floor of the cow stable, carried up by the dust into the lungs, from an accidentally abraded surface of which, it gains access to the current of blood, through which it is conveyed to the ovaries, or testes as the case may be, where under favorable conditions the evil consequences follow; and we have a well developed case of congenital tuberculosis in the calf. In this instance might not the hereditarian say, upon finding the sire and dam healthy, "Here is a case where the disease has skipped a generation, or two if necessary, and through atavism or heredity the old family complaint has come to life again," when really the disease may have come from another animal of a different breed, or race. To revert somewhat briefly to the word hereditary let me say that it is derived from a Latin noun *heres*, meaning an heir, the genitive case being used and suffix added to make up the word, it then evolves, when somewhat liberally translated into the phrase "*pertaining to the heir of*," Gould in his highly famous Dictionary of Biology and Allied Sciences, says it means, "acquired by inheritance," and speaks of it as the transmission of physical or mental qualities or tendencies from parent to offspring, while the same author in quoting Darwin's Theory of Heredity, supports the suggestion that each of the cells of the body gives off germinal particles, these when grouped constitute the generative cell, which in its turn is endowed with an inherent power to reproduce itself, as well as the peculiarities of the original organism. But the bacillus tuberculosis is an accidental invader of the cell of the economy, and is consequently a foreign body, just as much as a fine splinter of wood would be under certain circumstances, and has nothing whatever to do with the original constitution of that cell, therefore tuberculosis cannot be an hereditary disease. Another avenue of infection suggested by some, is the placenta or after birth, it being contended that these membranes

becoming affected from the mother are liable to communicate the disease to the young creature in *utero*, but looking at it from the anatomical standpoint we are forced to the opinion that the *placenta* is far more likely to be infected from the *fœtus* (creature before it is born) than the *fœtus* from the placenta, for we must remember that the blood of the mother does not at any time come directly in contact or mingle with the blood of the *fœtus*, but that there are no less than two membranes to be penetrated, the wall of the blood vessel of the mother, and the wall of the blood vessel of the placenta, before the germ can be conveyed to the *fœtus* in this way; while the communication from the *fœtus* to the placenta through the umbilical vessels is uninterrupted and continuous. We do not wish to infer, however, that the former method is impossible or even improbable.

SYMPTOMS.

It is most unfortunate that this disease invades the economy of an animal in such a subtle manner, that in many instances it has made extensive inroads upon the constitution before any extraordinary deviation from health is noticed. Recent experience has shown us that it makes considerable difference which avenue of infection the germs take to produce certain clinical symptoms, by which it can be diagnosed, though clinical symptoms even in these cases must be accepted with some reserve until, figuratively speaking, there is time to run the material through the bacteriological mill. The writer's attention has more than once been called to cases, diagnosed as tuberculosis, in which microscopical examination, as well as other bacteriological methods, showed the diseased condition to be the result of another cause. Sometimes the disease manifests itself in the beginning by an acute attack of diarrhœa, which often appears considerably better after judicious treatment, when we are liable to congratulate ourselves that the case is doing nicely, only to be disappointed, when some apparently trivial cause brings on a second and perhaps more acute attack; things may go along in this unsatisfactory manner for some time, when sooner or later the characteristic consumption begins and the case goes from bad to worse, and finally dies an emaciated looking object. A case like the above is more than likely to have derived its poison from the food, such as milk contaminated with the bacilli, or even grass upon which these germs have been profusely showered with the discharges of an affected animal. But the disease does not always take this rapid course through the alimentary canal. During the past year I have held post mortem examinations upon animal after animal, and found a vast preponderance of the diseased lesions in the glandular or lymphatic system, which is the intermediate channel between the food and the blood, indicating that the germs found access to the body again through the food, but apparently finding a suitable habitat, seemed to be resting quietly while the host in its turn was growing fat. Indeed, it was difficult for me to form an opinion in many instances whether the animal would die from the disease or old age, if left to take its own course. No doubt such animals are the most dangerous to have about, for they may spread the germs right and left without ever being suspected as having the disease themselves, because they do not show symptoms by which it can be

recognized through any known physical examination. Bacteriological examination might discover it, but in ordinary commercial veterinary practice that would not be likely to be made.

When the disease invades the economy through the organs of respiration by the inhalation of dust laden with germs, which were floating in the disturbed air of say, a recently swept compartment, the floor of which has been bespattered with the discharges from a diseased animal, and allowed to dry, a very different state of affairs may be manifested. The germ finding an abraded surface upon the lining of the air tubes of the lungs, will very likely lodge there, and form a colony, which in its turn will in time break up and scatter, forming many more colonies in the same lung, or other parts, and this sort of thing may go on until there is enough of these foreign elements in the lungs to irritate them, then the cough begins, followed sooner or later by loss of flesh. Nothing the animal eats seems to do it any good, in fact, it looses weight from day to day, typical consumption having set in, which only needs time to wipe out the existence of the creature.

All the living or organized tissues of the body are liable to be affected with this disorder, and of course the symptoms vary somewhat according to the organ or part affected. When the brain, for instance, is the seat of attack, then a variety of nervous symptoms will manifest themselves, according to the part of that organ affected. If, for instance, the part supplying vision becomes diseased, then amaurosis or paralysis of the nerve of special sense of sight may be brought about. In a similar manner the animal may become deaf, or the sense of taste or smell may be deranged. In other instances that part of the brain which controls the voluntary movements of the body becomes affected, and the creature moves about, if it moves at all, in a most eccentric manner; truly it is unbalanced. When any part of spinal cord becomes affected the symptoms vary from partial to complete loss of motion, or loss of sensation, or both. When the generative organs of the female become involved to a very large extent she will not procreate with certainty. I have seen cases where the womb was so diseased and distorted that it could hardly be recognized; indeed the same might be said of any organ in the body, so much so that it would require special description of individual cases to treat of the subject in anything like a full or exhaustive manner. But this is far beyond the limits of this bulletin. We must, however, dwell for a moment or two upon the disease as affecting the milk gland or udder; in this case there may or may not be acute inflammation of the part, but in well marked cases one or more tumors will make their appearance, which, under certain conditions as to time and growth, will literally pour out the germs of this disease, a strong argument in favor of having all milk disinfected by raising it to a temperature over and above the thermal death point of the bacillus, and keeping it there for a given length of time. Such a procedure will insure protection against those bacilli which are in the milk at the time it is drawn from the cow, but we must not forget that even such milk is liable to infection afterwards from other sources, and the housewife must not settle down with the idea that Pasteurized milk is proof against the germs of tuberculosis, or even others, for all time.

It is more or less unfortunate, in connection with tumors of the udder, that we cannot tell with certainty from ordinary clinical examination

whether they are caused by the bacillus tuberculosis or some other perhaps less harmful organism, without resorting to bacteriological methods. To those who are familiar with the pathological changes which occur in the tissues affected with tuberculosis, macroscopical (with the unaided eye) examination will enable them in many instances to differentiate with tolerable certainty between tuberculosis and some other disease. It is well known to veterinarians that the germ of contagious mammitis causes a certain amount of tumefaction of the udder, which might easily be mistaken for tuberculosis by a casual observer, or vice versa. While there is room for lengthy discussion upon such points, suffice it to say that milk properly disinfected by heat will not spread disease if used at the proper time.

We shall now pass on to the diagnosis or detection of the disease in its earlier stages.

At one time it was hoped that the microscopist could diagnose the disease with his instrument, and so he can in many cases, but because he does not find the germ in any of the excreta it does not prove the animal healthy; the germ may be there one day and away the next, or the poison may be eliminated in such a condition as to escape detection by known methods, so that his efforts are defeated. The bacteriologist might prove the presence of the germ by certain processes, but his mill does not grind fast enough for ordinary commercial purposes. However, in Koch's lymph or tuberculin, we seem to have an agent which so far surpasses all other known methods of diagnosis that comparison is not admissible. The discovery of this remarkable substance was first announced to the public about six years ago. At that time it was thought to be a curative agent for the disease. It did not, however, give as flattering results as was looked for, so it has been abandoned by many. However, future investigation may revive an interest in it, and show that it has an important curative effect if used under certain conditions, yet to be determined; but even without this curative value, tuberculin is now recognized the world over as the most reliable, safe and practical method of diagnosing tuberculosis in the early as well as later stages, that is in the possession of mankind, and consequently becomes a boon to our race. It may be interesting to note that when this agent was first used it caused an elevation of temperature above the normal 8 or 10 hours after it was injected, while it was soon discovered that animals free from the disease were not likely to be affected in this way. This soon led veterinarians to apply it as a diagnostic agent. Without following its history very closely let me say, that it has fought its way to the front inch by inch, as it were, until today it has few opponents, and the errors in diagnosis which were blamed to the tuberculin are now being accounted for in some other way.

Some asserted that an objection to its general use was that it caused reaction in other diseases, notably actinomycosis or lumpy jaw, while others contended that it left some cases of tuberculosis unaffected and missed them on account of the medicine not causing characteristic reaction.

With regard to the first objection I may say that while the agent may not be infallible, yet I have tested it in three cases of actinomycosis, or *lumpy jaw*, and it did not cause characteristic reaction. The contents

of several of the tumors, in two of the three cases, was examined microscopically for the bacilli and none were found. The same tumors were examined for the Ray fungus of Actinomycosis, and it was readily discovered in great profusion. Some of the material was injected into the abdominal cavity of a Guinea pig, with usual bacteriological precautions, but up to the present writing tuberculosis has not manifested itself.

In another instance I applied the tuberculin test to a number of cows; two of them had external manifestations of actinomycosis; one of them reacted in a manner indicating tuberculosis, the other did not; the inference was that one cow had actinomycosis and tuberculosis at the same time, while its stable companion, which did not react had only actinomycosis. It was my intention to have followed these cases step by step through the various bacteriological methods, but owing to the herd becoming involved in litigation I was unable to proceed in the manner I had first intended. With regard to the second objection I have to say that in my own experience I have held autopsies upon several animals, which presented very striking evidence of tuberculosis of the lungs, having more or less cough, capricious appetite, loss of flesh, even to emaciation, and general condition which would lead one to regard it as a case of tuberculosis. Yet autopsy failed to reveal any evidence at all in three cases of tuberculosis, two of which were diagnosed as chronic intralobular pneumonia; the third chronic indigestion. The fourth was followed further, even beyond the microscopic examination, and inoculation made in a Guinea pig, but the disease has not manifested itself by symptoms in that animal, although some six weeks has elapsed since the operation was performed. An autopsy will be held upon it in due time and report made as to the finding at some time in the future.

I have applied the tuberculin test to 698 animals in this State and found reaction in 77 cases. Autopsy and microscopical examination have revealed the presence of the disease in all cases where a post mortem was held. Some few animals, about 18, are now under observation, not having been summarily disposed of yet. One cow to which I applied the test behaved somewhat differently from the rest; her case deserves special mention. In August, 1894, I took this animal's temperature about six times, beginning at 8 a. m., and continuing at intervals of 2 hours through the day. Her temperature that day ran up to 105° Fah. With some reluctance I injected the usual dose of tuberculin about 10 o'clock the same night, and commenced thermal observations early next morning. continuing at intervals of two hours until the evening. The temperature of the animal did not go beyond 105° Fah., which, of course, did not indicate tuberculosis. I held a post mortem on this cow three months from that time, and discovered extensive lesions of tuberculosis in her lungs and liver. While the tuberculin did not diagnose the disease, yet it is hardly fair to blame it, as the cow was very far from her normal condition the day the medicine was injected. If blame is to be attached anywhere it is to the operator for applying the test on that day; but I had no information on the point, so I reasoned that if I did not try it I would not learn anything. The above brief history shows that as far as is known I had only one failure out of 698 cases, and that only a partial one.

TREATMENT.

As far as this phase of the disorder is concerned we must proceed in a somewhat conservative manner, although cases have been brought under the writer's notice which were most convincing that the disease has been overcome by the right kind of constitution and judicious manipulation of the patient. With this in view, it now becomes our duty to try to discover exactly what conditions or surroundings are necessary to overthrow the army of invading germs.

EXPERIMENTAL WORK.

In order to study this disease from the bacteriological standpoint additions are being made to our laboratory and suitable apparatus for doing the work will be at our disposal. As soon as this is completed those animals of the college herd which have reacted upon the application of the tuberculin test, will be the subject of investigation. Efforts will be made to determine to what extent the disease is thrown off by the discharges. The extent to which the discharges are capable of spreading the disease in the pasture will be sought. Frequent microscopical examinations will be made of the several excretions to determine the presence of the germ.

Inoculations will be made to determine to what extent the discharges will spread the disease without the germs appearing in them as fully developed bacilli. It is the intention that every stone shall be turned to reach conclusions as to peculiarities of the germs at all times. And last but not least, curative agents will be experimented with.

It has long been known that fresh air and sunshine will hold the disease in abeyance, while, at certain stages and under certain conditions, it may be entirely cured by them. With this in mind, the sunshine phase of the curative side of the question will be as fully investigated as our ability will admit, and the various rays, X rays and other kinds, which may exist in this planet will be given ample opportunity to exert their influence upon the germ. Control animals will be kept when possible, and carefully observed. The effect of tuberculin on the economy will be closely watched; and no doubt many experiments at present unthought of will be formulated during the progress of the investigation, with the hope of combatting the progress of a disease which is known the world over as one of the greatest enemies to mankind.

Since the foregoing was put in print I have had occasion to test a herd of dairy cattle and several calves. There were 26 animals in all, 9 of which reacted, after the administration of the tuberculin, in a manner indicating tuberculosis. Among the 9 head which reacted were two calves, each one month old, which possessed a more or less interesting history; one of them being the calf of a cow that had recently died of tuberculosis. The other was from a cow which, although tested with tuberculin, did not react. So that, as far as could be discovered, she was healthy. Both of the calves were fed on the milk of the tuberculous cow, and both of them showed extensive lesions of the disease upon post mortem examination. While these facts may not prove that the calves

actually contracted the scourge from the milk of the affected cow, there being several other channels through which the poison may have been introduced, yet the case is surrounded with a good deal of suspicion as far as the milk is concerned, and may reasonably be regarded as a link in the chain of evidence supporting the assertion that milk coming from afflicted cows may cause the disease in healthy animals, especially when it is the main article of diet.

To continue the investigations, already commenced in the college herd, it was arranged, after testing the animals with tuberculin, to select from them one showing a typical reaction required by the conditions of the test, for post mortem examination. A grade cow named Hebe, test number 36, was singled out, and an autopsy held upon her, which revealed nodular deposits resembling those caused by *tuberculosis,* in lymphatic glands between the lungs, in the throat, in the walls of the small intestine, and in the mesentery (curtain of the bowels). Small particles of this tubercular material were then passed through other animals, in order to study the matter from a bacteriological standpoint. This part of the work was pursued in the following manner, to wit: Three Guinea pigs were selected and the substance placed under the skin of the back, No. 1 being inoculated with material from the nodules of the small intestine, No. 2 with material from the nodule of the mesentery, No. 3 with material from the gland between the lungs. The inoculations were made on the 15th of April. About the 1st of May Nos. 2 and 3 began to show evidence of consumption, and the wasting continued from day to day until the 28th of May, when No. 3 died, during the night. On account of certain of the bacteriological apparatus not having arrived the microscopic examination of the lesions which were presented could not be made in the fresh state, although the onset, course, termination, and post mortem macroscopical lesions, were essentially the same as those in No. 2, which was killed later, leaving little if any room for doubt that tuberculosis was the cause of the trouble.

No. 2 showed more apparent evidence of consumption than No. 3, being eventually reduced to little more than skin and bone. As soon as the proper stains, and apparatus, arrived for following the case through the microscopical field, the animal was killed, autopsy revealing essentially the same lesions as in the case of No. 3. From the point of the inoculation in the back, the progress of the disease could be readily traced through the lymphatic glands, those on the inoculated side of the body being most affected.

The liver, spleen, glands between the lungs, and other parts were diseased. Microscopical examination of the substance of the lymphatic glands, stained according to the Ziehl-Neelsen method, showed them to be literally loaded with the bacilli of tuberculosis.

AGRICULTURAL COLLEGE, MICH.,
May 1, 1896.

A PRELIMINARY BULLETIN

ON THE

PASTEURIZATION OF MILK.

CLINTON D. SMITH.

SUMMARY.

The investigations of Pasteur, Koch and others have gone far towards demonstrating that consumption, or tuberculosis as it is now called, as well as other infectious diseases, are transmissible from cattle to human beings through the medium of the milk. The application of the tuberculin test to dairy herds in this State has shown that the disease is not infrequent in cows, and that, therefore, milk may be a fruitful source of the disease among human beings.

The bacteria, which are characteristic of this dread disease and which are believed to be its cause, have been carefully studied, and means of killing them in milk, and thus rendering this article of food safe, have been devised. *It has been found that if the milk containing the germs be heated to 155 degrees F. for twenty minutes as a minimum the germs will be killed and the milk will not convey the disease to the consumer.*

The experience of physicians from time immemorial in dealing with the hygienic conditions of infants and young children has led them to recommend boiling milk, or at least scalding it, for their use.

It is the purpose of this preliminary bulletin on pasteurization to state briefly the facts on which the process is based, together with a brief description of some of the simpler methods and apparatus for conducting the operation.

The word pasteurization is derived from the name of a French scientist, Louis Pasteur (born Dec. 27, 1822, died Sept. 28, 1895), who was among the first to study the realm of bacteria as related to diseases of animals and man in a scientific manner. He showed that fermentations such as occur in the souring of milk are due to the presence of living organisms, not to some quality necessarily inherent in the material itself or any of its constituents. He also demonstrated by experiment that heating milk to a certain temperature would kill the germs which it contained and would therefore either prevent or at least delay subsequent fermentation according to the thoroughness of the operation and the

degree of heat applied. For this reason the method of delaying the souring of milk by application of a degree of heat sufficient to kill the adult germs but not enough to boil the milk or kill the spores, is called pasteurization. The effectiveness of the operation, as will be discussed later, depends on heating the milk to at least 155 degrees as a minimum temperature for at least twenty minutes as the minimum time.

The word sterilization is not synonomous with pasteurization but is applied to a much more thorough treatment. Milk is said to be sterilized when all the germ life which it contains, whether in the adult or spore state, is killed. To affect this end the milk must be heated to the boiling point at least, and the operation should be repeated at least once after an interval of a couple of hours, to secure perfect results.

In pasteurized milk, therefore, souring is delayed only; by sterilization it is prevented. Perfectly sterilized milk will keep sweet indefinitely if bacteria from without are excluded.

The problem presented to the milk dealer is to provide milk in which the adult bacteria are killed and which has not at the same time a boiled or cooked taste. The solution of the problem depends upon a strict observance of certain well defined rules as to temperature and time. With the housekeeper the question is much simpler. Unless the boiled taste is objectionable to some member of the family, she has but to boil the milk, preferably in a double cooker, to prevent burning fast to the bottom of the vessel, and all the bacteria whether harmful or otherwise are killed.

After boiling, the milk must be kept in a covered vessel and contact with the air, as far as possible, prevented.

No special apparatus is required for pasteurizing milk. Any apparatus that will comply with the conditions named above is acceptable as far as the efficiency of the process is concerned. As a matter of convenience, ease and certainty of operation, certain forms of utensils are suggested. Clean, bright tin pails are to be preferred to glass cans because they will bear sudden cooling in ice water.

Milk can be pasteurized economically on a commercial scale by using the methods and apparatus described. When kept clean and cold from the time it leaves the udder of the cow, milk keeps wholesome much longer than if exposed to contamination by dirt or foul odors.

There is a grave danger of imbibing the germs of tuberculosis in raw milk from tuberculous cows. This danger is greatly reduced if not entirely removed by thorough pasteurization.

MILK AND BACTERIA.

The housewife judges of the richness of the milk in fat by the amount of cream that rises when the milk is set for a few hours in the pantry, but may have no conception of the quantity or peculiar qualities of the other ingredients of this universal and exceedingly perishable article of food or the part they play either in its food value or decay. It would be manifestly out of place to go into a detailed description of the various components of milk in this bulletin. It is enough for our purpose to briefly mention such of the salient features of its principal elements as are con-

cerned in methods of treatment to preserve it or to render it safe if the seeds of disease have been sown in it either in the milk glands of the cow or later by infection from the air.

An idea of the quantities of the different ingredients in milk of average composition may be obtained from the following table which gives the amount of each in twenty pounds, approximately ten quarts:

Water	17.50	lbs.
Butter fat	.68	"
Casein	.78	"
Milk sugar	.90	"
Mineral matter	.14	"
Total	20.00	"

The butter fat exists in milk in minute globules visible under the microscope. These globules rise to the surface when the milk is set for cream, being lighter than the liquid part of the milk. When the milk is heated to a high temperature these particles of butter may lose their globular form and coalesce. This is a point to be remembered when the attempt is made to sterilize milk at excessively high temperatures.

There is nearly one-half more sugar than butter fat in average milk.

This sugar differs from the cane sugar of commerce in that it has little sweetening power and is not readily soluble in water. It is nevertheless a true sugar and has a food value equal to cane sugar. It is this constituent of milk that is acted upon by bacteria and is concerned in the process of souring. Certain microorganisms which feed upon milk sugar gain access to it both before it has left the udder of the cow and afterwards during its progress through the dairy. They convert it into an acid. This lactic acid as it is called gives the milk its sour taste and also curdles it by acting on the casein or cheesy matter, rendering the latter insoluble in the liquid part of the milk. This souring of milk is due then entirely to the presence of certain forms of bacteria. To prevent it we have but to exclude them at the outset or kill them if present and the milk will remain sweet indefinitely.

The fact that ten quarts of milk contains sufficient caseous material for more than a pound of cheese is of importance in considering its food value. This cheesy matter in almost perfect solution in milk is an important factor in its souring and spoiling, since as soon as a small per cent of lactic acid is formed by the bacteria the casein is curdled and the milk is spoiled for drinking purposes. Milk that has the slightest taint of sourness cannot be used for pasteurization as the application of heat hastens the coagulation of the casein. It is the albuminoid constituents of milk which are acted upon by a certain comparatively low degree of heat giving the milk a cooked taste, hence it is necessary in pasteurizing milk not to allow its temperature to rise above this point, which our experience indicates to be about 160° Fah.

The extremely complex composition of milk and the fact that its constituents are, except fat, in solution, render it an excellent soil for the growth of bacteria. These minute vegetable organisms, invisible except under the highest powers of the microscope, are floating upon the dust of

the air of the cow stable, the milk room, the dairy, the kitchen and the pantry. They are attached to the sides of the vessels which contain the milk or transport it from the barn to the dairy house or from the farm to the city. They are well nigh ubiquitous. The skill of the dairyman is measured by his success in excluding them from the milk which he offers for sale or uses in his dairy. This success will depend to a large extent upon the cleanliness of his premises, utensils and methods. The cleaner the cow stables, the utensils and the dairy room, the sweeter and purer will be the product and the longer it will keep.

The size of these bacteria is so infinitesimal that of some species 50,000 placed end to end in a line would scarcely reach the length of an inch. Some of them are spherical, others are oval, others are short rods, still others are spiral, and finally others are grouped in cubical masses or are arranged in a line like a string of beads. In structure they are extremely simple, consisting usually of a single cell. One of their chief peculiarities, and the one which above all others gives them their extraordinary power, notwithstanding their minute size, is their rapid multiplication. In some cases a single individual may in one period of 24 hours give rise to 20,000,000 offspring.

This wonderful reproduction is accomplished in one or both of two ways.

A single germ may grow in length for a time, then by gradual constriction of its outer coat divide itself into two. Each of these parts then becomes an adult individual capable in turn of absorbing its proper nutriment, elongating and dividing itself into two other microbes. The period of time required for this growth and division varies with the different species. It may not exceed twenty minutes. It is evident then that in the course of 24 hours the number of offspring to which a single specimen may give rise is simply enormous.

A second method by which bacteria multiply is by the production of spores. These spores are still more minute than the adult bacteria. They appear within the full grown bacteria and, after the apparent death of the latter. remain to perpetuate the species. In most cases they are able to survive conditions that would cause the death of adult germs of the same species. Exposure to a degree of heat sufficient to cause the death of bacteria proves in most cases insufficient to kill the spores. Bacteria live usually in moist substances, but the spores will endure drying up and may thus bridge over, for the species, the lapse of a period when the moist food supply is exhausted and revive the species when favorable conditions again return. They may be blown about in the air, therefore, and be ready to germinate as soon as they alight upon the food to which they are adapted.

Two conditions are absolutely essential to the activity and multiplication of bacteria, heat and moisture.

Below 50° Fah. bacteria germs of all kinds grow very slowly, and below 40° they become dormant. *All milk bacteria thrive best at temperatures between 70 and 100° Fah. Between these limits they multiply with great rapidity; hence in treating milk, it must not remain long luke warm. but must be both heated and cooled rapidly.*

The bacteria of milk are killed by heating it to a temperature which varies with the different species. Investigations have demonstrated, however, that 155° Fah. will kill both the bacteria engaged in souring

or spoiling the milk and the disease-producing germs as well, if maintained for twenty minutes. It will not, however, kill the spores. These minute bodies are singularly resistant to even extreme heat and the milk must be boiled and the boiling repeated to insure the death of all the spores.

Of the bacteria resident in milk as found in the dairy house or market there are many species. These species differ from each other in form, in the constituent of milk upon which they feed, and finally in the effect they have upon the milk as a whole.

Some species feed upon the milk sugar only, converting it into an acid. These species have been carefully studied and identified. In dairy practice it is found that these bacteria gain access to the milk early in its history, even before it leaves the udder. They are peculiarly susceptible to heat and are killed by a comparatively low temperature applied for a short time. Exposure of the milk to 140 degrees Fah. for fifteen minutes will kill these germs (Wis. 12th An. Rep't, page 163).

Other species, whose functions seem to be to induce putrefaction or spoiling, are not peculiar to milk as are the souring germs. They are present in every dairy house and every kitchen and fall upon the milk as as they fall on every other putrescible substance and set up at once fermentations that end in the more or less complete destruction of the material. These species differ from each other widely as to the results of their activity. As different species of flowering plants are able from the same soil to bring forth products varying in quality from rank poison to useful food, so these bacteria may generate ptomaines as in the case of tyrotoxicon, or cause decay simply, or produce a mixture of results not particularly harmful to grown people but unsafe for infants. These fermentative changes go on entirely independent of the souring processes. Usually they follow them, but may go on at the same time or even precede.

When milk "does not agree with" infants, the property of the milk to which this unhealthfulness is to be for the most part ascribed is the presence of these bacteria or their products.

Dr. Louis C. Parkes, of the London University, makes the following statement in his work on "Hygiene and Public Health," page 332: "Milk which has become acid from lactic fermentation is liable to cause sickness and diarrhea in children. * * * We thus see that cow's milk may become injurious from the fermentative changes to which it is liable after exposure to the air; from its capacity for absorbing foul gases and vapors when stored in uncleanly places; and from its ability to harbor and foster microbes and spores which may come into contact with it, all the causes operating after the milk has been drawn from the cow."

Dr. Koplik says (New York Medical Journal, February 4, 1893), "that in his experience in the city of New York he has seen children flourish amidst the most unfavorable surroundings when their food and milk supply was derived from his dispensary, where it was thoroughly pasteurized under proper conditions, while in the same districts other children which were left to the carelessness of the mother were sick and puny."

It is needless to quote farther authorities upon this point, since it is generally conceded that the liability to bowel difficulties with children is very largely due to bacteria in milk and is greatly diminished by killing these germs in the milk given them.

SOURCES OF INFECTION.

Non-Pathogenic Bacteria.—Grotenfeldt assures us that in the udder of a healthy cow, milk is absolutely free from bacteria of any kind. This is a matter of little practical importance since, at the very beginning of its movement toward the outside world, it meets with the source of infection in the milk gland itself. These bacteria in the teat and possibly even in the milk cistern itself are the ones which are largely engaged in the souring process, and are not the ones which bring about the putrefactive fermentation. According to Russell (12th Annual Rep. Wis. Exp't Station, page 168), "the lactic acid bacteria—those that are essentially milk bacteria by predeliction are the forms that are habitually present in the milk duct. These are the bacteria that cannot well be kept out even by the greatest care. These are, however, the forms that succumb most easily to the pasteurizing process."

The second source of infection is dirt falling in the milk in the stable. If the flanks of the cow and her udder are not well brushed before milking time, and her udder and adjacent parts dampened as the milker sits down at her side to prevent the falling of the loose hair and scurf into the milk, the latter becomes thoroughly inoculated with putrefactive germs. Prof. H. W. Conn in his address before the Ayrshire Breeders' Association states (Hoard's Dairyman, 1896, page 192), that "by the time the milk reaches the milk pail it will contain from 30,000 to 5,000,000 bacteria per cubic inch." It must be remembered that the keeping quality of the milk varies inversely as the germ content. If there be but few bacteria, it will keep sweet a long time even under adverse conditions of temperature. Experience has shown that it is better to exclude the bacteria than cure the effects of their presence.

Dr. Russell of the Wisconsin Experiment Station mentions an instance where, in the mixed milk taken in the ordinary way, there were "found 15,500 bacteria per cubic centimeter, while the average of the total yield of a cow that had been carefully cleaned and the milking done in the manner already suggested contained only 330 bacteria for the same volume."

Grotenfeldt laid particular emphasis on the necessity of extreme care during the act of milking, and the following quotation shows the kinds of stuff that may be found in milk when the milker is careless:

"As the impurities which get into the milk, even during the milking itself, plays such an important part in the infection of bacteria, it is important to learn their origin. The microscopic examination gives a good indication of their origin. I have found the following kinds of impurities in unstrained milk fresh from the cow:

1. Manure particles (numerous).
2. Fodder particles (which have not passed the alimentary canal of the animals).
3. Molds and other fungi.
4. Cow hair (numerous).
5. Particles of the skin.
6. Human hair.
7. Parts of insects.
8. Down from birds.

9. Small wooden pieces, shavings and pieces of fir leaves.
10. Woolen threads.
11. Linen threads.
12. Soil particles (rather frequent), and moss particles.
13. Fine thread, most likely cobwebs.

In these investigations I also found several impurities in the milk whose presence I was unable to explain, as, for example, cheesy lumps, slimy substances with a firmer nucleus, shining fatlike bodies, fine floss and grain and similar matters. As regards the liquid impurities appearing in the milk, it need hardly be mentioned that they cannot be detected by microscopic examination." (Woll's translation of Grotenfeldt, pages 31 and 32.)

It is reasonable to suppose that the strainer would remove the coarser particles, but no filter could be close enough in texture to remove the contaminating bacteria with which they are laden. The particles of manure convey to the milk the digestive ferments from the bowels of the cow. In the milk they set up that class of fermentation that give to it a slimy physical condition and decidedly unpleasant flavor. The well known "cowy" taste detected in the milk from stabled cows or from cows newly turned on grass is rarely inherent in the milk itself as it comes from the udder, but is due, very largely at least, to the careless admission of particles of manure which bring with them nasty intestinal juices and putrefying bacteria. *No pasteurizing process can cure or cover up the evil results of nastiness in milking.*

A third source of infection is the air of the cow stable. In its progress from the teat of the cow to the pail, the milk is exposed to contaminating dust floating in the air. The amount of infection from this source will depend upon the construction of the stable, the stall fittings used, the method of ventilation, the use of bedding and methods of feeding. If the ceiling, walls and floor of the cow stable be smooth and clean so that no excrement or vile matter of any kind is allowed to accumulate and decay, and if the stable is light and airy, plenty of sunlight admitted, the cows turned to the open air frequently, and the stables at the same time thoroughly aired, the danger of contamination of milk from this source is lessened. If the stall fittings are such that the droppings of the cow are not allowed to constitute part of her bedding, if the flanks and udder and tail of the cow are free from particles of manure either fresh or dry, and finally, if neither the bedding nor coarse fodder are stirred for some time before milking, the amount of the dust in the air, and, as a consequence, the amount of bacterial infection from this source will be reduced to the minimum.

The fourth source of infection is dirt on the milk pail and the dairy utensils generally. Unless these utensils are thoroughly clean, although the visible dirt may be removed, the bacteria will not be killed, but will remain to infect the next supply of milk which the vessel may receive. To properly clean the dairy utensils means to kill these bacteria. This necessitates first the removal of the milk adherent to the sides and bottom of the vessel by rinsing in cold or tepid water. Next the vessel must be thoroughly scoured in hot water, using a brush in preference to a cloth. Next it must be thoroughly rinsed in boiling water. If steam is provided in the dairy it should then be subjected to live steam, followed by a sun bath. This method will remove the major part of the germs

adherent to the sides of the vessel or hidden away in the cracks and seams. Where the cans or bottles are to be used for pasteurized or sterilized milk or cream, farther disinfection is necessary as will be discussed later.

It is apparent that the chief sources of infection could be described by one short word, *dirt*. The old maxim, "Cleanliness is next to Godliness," has no application more apt than to the handling of milk.

PATHOGENIC BACTERIA.

Milk that has either become sour or begun to spoil is indeed not wholesome, yet the germs which have produced these fermentative changes are not related to any particular disease, nor does their presence render the milk dangerous to the health of the adult consumer. There is sometimes present in milk, however, an entirely different and distinct class of these microscopic bodies, which may convey to the consumer the disease of which they are the characteristic germs.

Numerous cases are on record, for example, where diphtheria, scarlet fever, typhoid fever or cholera have attacked a large number of individuals in the same community, and the source of the epidemic has been traced directly to the use of infected milk. A biological examination of the milk in such cases has revealed the presence of the minute germ which is the cause of the particular disease.

Fortunately outbreaks of the diseases mentioned are not frequent, yet the danger of deriving them from milk is never entirely absent, especially when the city consumer buys his daily supply from a source not under careful sanitary inspection.

Of all the specifically communicable diseases which afflict humanity, consumption, or tuberculosis, as it is now called, is by a long way the most to be dreaded. Dr. Law, of the Cornell University, says of this disease in a bulletin to which we shall have occasion to refer frequently (Cornell Experiment Station, Bulletin 65):

"Tuberculosis is so extensively prevalent and proves such a veritable scourge throughout the civilized world that no disease is so deserving of close and accurate study or of the enforcement of effective measures for its suppression. Cholera, yellow fever, and smallpox, which occasionally invade our territory, creating universal terror and dismay, claim but few victims as compared with this ever-present, universally devastating plague. These other plagues are quick, severe and fatal, it is true, but for this very reason they can be promptly recognized and checked, and even stamped out, whereas tuberculosis is equivocal and underhand in its method, slow and uncertain in its progress, and on this account escapes recognition and proves by far the most deadly of any single disease attacking the human family. The average ratio of deaths from tuberculosis to the total mortality is fourteen per cent, or one death in every eight, while under special conditions it rises to one in three, as in the Marquesas Islands, or even one in two, as in some of our Indian reservations. Tuberculosis may be classed with 'the pestilence that walketh in darkness,' while the three other diseases named are like 'the destruction that wasteth at noonday.' But the deaths from tuberculosis being constant and uniform, people accept them as inevitable and fold their

idle hands with true Mahomedan fatalism instead of boldly exposing the hidden death trap and cutting short its destructive work. * * * If we take the whole civilized world and compare with the tuberculosis mortality, all the accumulated deaths from war, famine, plague, cholera, yellow fever and smallpox, we find that the latter are comparatively very insignificant. Yet tuberculosis, like every other germ disease, is absolutely preventable, and is allowed to continue its career of death only because of reprehensible ignorance and criminal indifference."

At first sight statements like the above, even from this well known and thoroughly competent anthority, strike one as gross exaggerations, yet the statistics of mortality in our own country most eminently justify them. It is a matter then of great importance to the milk consumer to know whether the prevalence of this disease among human beings can be at all traced to infection through the milk of diseased cows, and if so whether by any treatment of the milk the danger may be guarded against.

That tuberculosis is a communicable disease, and is therefore conveyed from a sick to a healthy animal through the medium of its characteristic germ, is abundantly proven. This germ has been recognized, identified and described. Dr. Grange states in bulletin 133 of this Station, page 4, referring to the works of Koch, "In this volume it is clearly shown that the disease is due to the presence of a minute rod, which gains access to the economy of its host, in one way or another, and is now known as the 'Koch Bacillus of Tuberculosis.' "

INFECTION THROUGH MILK.

This germ may enter the body of the human being through many avenues. The one most commonly traversed is the lungs. It has been shown that tubercular germs retain their vitality even when desiccated and blown about in the dry air of a room or stable. If, therefore, the matter coughed up from the lungs of an animal or man afflicted with pulmonary tuberculosis is allowed to fall upon the floor, it may there become dry, be pulverized into dust and be blown about in the air, still retaining its vitality and its ability to communicate the disease to the animals which inhale the dust-laden air.

While there can be no doubt that this is the main avenue of infection as far as human beings are concerned, evidence is not wanting to support the statement that tuberculosis is sometimes conveyed to men from diseased cows, through the milk. It is evident that if it is clearly shown that the disease may be thus conveyed, it becomes the imperative duty of every housewife to see to it that the milk consumed in the household shall be so treated as to rid it as far as possible of the germs of the disease. Fortunately the necessary treatment of the milk is not a difficult one or one requiring expensive apparatus. As far as the milk supply is concerned, the family of the poor man in the city can be as easily and securely guarded against danger from consumption as can the family of his most opulent neighbor. It becomes, therefore, an important question in this respect whether the milk is really a source of danger. A few authorities are here quoted to show the present trend of investigation and opinion on the point.

Dr. Law, in the bulletin already referred to (Cornell Bulletin 65, page 137), says of the danger of infection of man through the milk: "Instances of accidental tuberculosis of the human being through drinking the unsterilized milk are no longer wanting.

"In the practice of Dr. Stang, of Amorback, a well developed five year old boy from sound parents, whose ancestors on both male and female sides were free from hereditary taint, succumbed after a few weeks illness with acute milliary tuberculosis of the lungs and enormously enlarged mesenteric glands. A short time before, the parents had their family cow killed and found her the victim of advanced pulmonary tuberculosis (Lydtin)."

"Dr. Demme records the cases of four infants in the Child's Hospital at Berne, the issue of sound parents, without any tuberculosis ancestry, that died of intestinal and mesenteric tuberculosis, as the result of feeding on the unsterilized milk of tuberculous cows. These were the only cases in which he was able to exclude the possibility of other causes for the disease, but in these he was satisfied that the milk was alone to blame."

"After a lecture of the author's at Providence, R. I., a gentleman of North Hadley, Mass., a graduate of the Massachusetts Agricultural College, publicly stated that his only child, a strong, vigorous boy of one and one-half years, went to an uncle's for one week and drank the milk of a cow which was shortly after condemned and killed in a state of generalized tuberculosis. In six weeks the child was noticeably falling off and in three months he died, a mere skeleton, with tuberculosis of the abdomen. The father could trace no tuberculosis among his near ancestors, but the mother's father and uncle had both died of it. She remains in excellent health."

"Dr. E. O. Shakespeare (Med. News, March 26, 1892), attributes one-fifth of all deaths in infants and young children, feeding on milk, to tuberculosis usually commencing in some part of the digestive organs."

The following instances are quoted from Vermont Experiment Station, Bulletin 42, pages 54 and 55:

"Dr. Anderson, of Seeland, reports the case of a babe fed on the milk of a cow having tuberculosis of the udder. The child died at six months with tuberculosis. The mother also developed symptoms of the disease after the child's birth. It was considered that both contracted the disease from the cow's milk."

"Ollivier, at a meeting of the Academie de Medicine of Paris, stated that a patient of his, a young woman twenty years old, of vigorous health and without constitutional trouble, had acute tubercular meningitis (inflammation of the membranes of the brain of tubercular origin). She had been educated at a boarding school where thirteen pupils had been ill and six died of tuberculosis within a few months. The milk supplied to the school was from cows kept on the place. Upon examination these animals were found to have tubercular ulcers on their udders, and, after being slaughtered, were found to be generally tuberculous."

"A Scotch family, all of sturdy health, had a herd of cattle which developed tuberculosis. Two daughters, being young, were brought up on the milk. Their two older brothers were more fond of whisky than of milk. They are living, healthy and hearty, while their two sisters are lying in their graves, victims of tuberculosis."

"A child four years old, great grandson of Henry Ward Beecher, died last March at Yonkers, N. Y., of tubercular meningitis. The diagnosis was confirmed by specialists. There were no hereditary tendencies to the disease known. The certainty that he had the disease, and the inability to account for it from human agencies, led the physicians to suspect the milk of two Alderney cows, on which the child had been mainly fed. Both the tuberculin test and the post mortems showed that both animals were tuberculous. Through the kindness of Dr. J. S. Lamkin, of Yonkers, who made both tests and post mortems, sections of the lungs and a gland were sent to us. They were found to be highly tuberculous."

"May 30, 1879, a cow died of generalized tuberculosis in Providence, R. I., the lungs, most of the abdominal viscera, muscular tissue and udder being tuberculous. The milk had been used in the family. In August, the baby was taken sick and died in seven weeks of tubercular meningitis. Post mortem showed tubercular deposits in the membranes covering the brain, and some in the lungs. Two years later a two-year-old child in the same family died of tubercular bronchitis, and seven years later a nine-year-old boy, 'delicate' for years, died of 'quick' consumption. So far as known the family on both sides were rugged and healthy."

"Dr. H. M. Pond reports four cases of tuberculosis in one family, of which three were fatal. He considered the milk of their cows to be the source of the disease, since those animals were apparently tuberculous."

"In the spring of 1890, Dr. Gage, city physician of Lowell, Mass., had, as a patient, an infant which died of tubercular meningitis. Its parents were healthy, and surroundings good. It had never been fed anything but the milk of a single cow. The cow's milk was microscopically examined and found to contain the bacilli of tuberculosis. Guinea pigs inoculated with her milk developed the disease. A second child, fed upon the same milk, was developing similar symptoms to those discovered in the child that died. Dr. Gage could find no way to prevent the sale of the milk unless he bought and paid for the cow out of his own pocket. So far as he knew she was still being used for a milk supply a year later."

"Dr. E. O. Shakespeare, Ex-U. S. Cholera Commissoiner, says, 'with all its terrors, it (cholera) is not nearly so deadly as is tuberculosis,' and 'it has been found that in infants and young children in some large cities the mortality from some form of tuberculosis is far greater than is generally believed, amounting, in some localities, to one-fifth of the deaths in the young. The significant fact in this connection is that it is most frequently some part of the digestive passages that become first affected."

The list of similar well authenticated instances of exceedingly probable transmission of tuberculosis to human beings through drinking the untreated milk of diseased cows might be indefinitely lengthened, but enough has been said to show that danger from this source can no longer be denied.

While the germ of tuberculosis is fairly resistant to heat and cold, it is fortunate, as already said and here repeated, that when present in milk it is killed by boiling the milk or even heating it to 155° Fah. and holding it at that temperature for 20 minutes. Fortunately, though the danger is grave, the remedy is simple and in the hands of every housekeeper.

PREVALENCE OF TUBERCULOSIS AMONG COWS.

Since the milk of tuberculous cows is thus shown to be dangerous to health it might be well to inquire whether the disease is at all common among dairy cows. Unfortunately there are no statistics at hand from which we can derive an answer to the question. In bulletin 133 of this Station, Dr. Grange reports that he has examined by the tuberculin test, 698 animals, of which 77, or over 11 per cent of the animals tested, were found to be affected. Many, perhaps most of these tuberculous animals, gave no external sign of the presence of the disease. They were often as sleek, lively and apparently healthy as their sound stable mates. One of the chief sources of danger lies in this very fact that there are no well defined external symptoms. It may be present in a herd and be disseminated from one animal to another without giving the slightest indications of its presence. The milk in such cases will be used in the family of the owner or shipped to the city with no suspicion of the danger that lurks in it.

This entire lack of external and easily recognizable symptoms of the disease even when present in an aggravated form absolutely prevents the gathering of statistics except upon a thorough inspection with the tuberculin test, which has not yet been attempted in a systematic manner in this State.

The prevalence of the disease varies with the surroundings of the cows. Law gives the following figures (Cornell Bulletin 65. page 107):

"In infected breeding and dairy herds in New York, consisting largely of mature cows, I have found a maximum of 98 per cent and a minimum of 5 per cent. Again in healthy country districts I have found hundreds of cows in adjoining herds without a trace of tuberculosis among them."

Less danger is to be apprehended from the milk of herds which are not closely confined, than from the pampered or carefully housed cows which furnish a large share of the milk for city consumption. Near every large city the price of land is high and the necessity for closely husbanding every foot of it is apparent. Soiling must take the place of pasture and the unfortunate dairy cows must be confined in the stable the greater part of the year. Not infrequently the ambitious but ill advised owner of thoroughbred specimens of dairy cows thinks it necessary to carefully house his animals to obtain records which shall bring his herd into repute. It is in the milk of these closely confined cattle, I repeat, that the chief danger lies.

MILK OF TUBERCULOUS COWS UNSAFE IF UDDER UNAFFECTED.

It was formerly supposed that no cow would shed the germs of tuberculosis into the milk unless afflicted with tuberculosis of the udder.

In a bulletin of the Experiment Station of the Agricultural College of Iowa, the following statements are made as a result of investigations conducted by several scientists:

"Milk from tuberculous cows may convey disease to the consumer.

"Milk from tuberculous cows having non-affected udders may convey the disease."

In the report of Cattle Commissioners of Massachusetts for the year 1895, included in the report of the State Board of Agriculture of that state for that year, on page 522, occur the following sentences: "Milk is more to be dreaded than meat because it is taken raw and the udder is so often the seat of tuberculosis. Even in the absence of tuberculosis of the udder the milk is sometimes infected."

Fraenkel states (Text Book of Bacteriology translated by Linsley 3d edition 1891, page 241), "The investigations of Bollinger, Hirschberger and others have shown that even where the udders themselves are not tubercular, the secretion of the mammary glands may contain bacilli and also that in nearly half of all tubercular animals the milk prove to be infective. The bacteria will then enter the human body with the food, by virtue of their covering they resist the acid gastric juice without the aid of spores and then get into the intestines, from which they are carried to the lymphatic glands. It is evidently unsafe then to use the milk of any tuberculous cow, no matter where the disease may be located."

NEED OF REGULAR OFFICIAL INSPECTION OF DAIRY HERDS.

It must be continually borne in mind that the aim of all treatment of milk as an article of food is to be directed toward providing milk free from bacteria and the effects of their activity. Such milk will be sweet and wholesome and at the same time free from the germs of disease. The effort to this end should be put forth in two directions, first to secure milk as free from bacteria of all kinds as possible, and secondly, to apply methods to kill the germs present in the milk.

The germs of tuberculosis may best be excluded by using the milk from cows proven free from the disease by the application of the tuberculin test, as described by Dr. Grange in bulletin 133. While this substance is not an infallible diagnostic agent, it is more certain in its indications than any other means of examination now in the hands of veterinarians and gives to the dairyman the power to pick out the diseased animal from his herd. It is both the right and the duty of every milk consumer to refuse to purchase or use milk from an untested herd. One human life is of infinitely more value than many herds. As soon as this demand becomes sufficiently extensive and emphatic the milk producers will yield to it. Until the use of the tuberculin test is more widely understood and prejudice disappears we can hardly hope to make a successful warfare against this greatest scourge which afflicts humanity at the present time.

The germs of other most infectious diseases gain access to the milk after it is drawn from the cow. The consumer can be insured against them by inspection of the premises where the milk is produced. As suggested by Scholl ("Die Milch," Wiesbaden 1891, page 63), this inspection should be officially regulated by law and not infrequent. It is in this way alone that we can be insured against the delivery of milk to factories and to the city trade from animals afflicted with infectious disease.

What is true in Germany is true in this country and we would do well to profit by their example. We can but agree with the dictum of Dr. Benj. Ward Richardson in his work on "The Field of Disease, A Book of Preventive Medicine," page 681. He says: "After the water supply

which, in past days, has been a frequent source of communication of the Zymotic diseases, the milk supply of the place should be most carefully supervised. Cow sheds in the midst of human communities in which cows, like animal machinery for producing milk, are kept, perhaps for months together, in partial darkness, dirt, close air and often without provision for the separation of healthy from unhealthy animals, should be entirely abolished. Milk supplies, like meat and vegetable supplies, should be under systematic supervision."

A thorough, compulsory, frequent, official, veterinary inspection of all herds supplying milk to either factories or cities is an essential prerequisite to freedom from infection of human beings through milk.

MILK PRESERVATION.

By Cooling.—It has been repeatedly demonstrated that bacteria grow and multiply very slowly indeed when the milk is at a temperature below 50 degrees Fahrenheit, and it is the every day experience of the dairyman that milk kept cold will remain sweet for a long time. Taking advantage of this fact it is the universal and wise practice of the dairyman to cool his milk as soon as it reaches the dairy house and as soon after milking as possible to a temperature below 50 degrees. This practice rests upon sound bacteriological principles. No pretense is made of killing the bacteria, they are simply held in check and their growth retarded.

Where it is desired to keep the milk sweet for a short time only, for delivery to a factory, for instance, cooling to 50 degrees or lower, and keeping at that temperature is sufficient. Where the milk is to be transported long distances in warm weather, special and costly apparatus in the shape of refrigerator cars are necessary, but need not be here described.

For the farmer and dairyman the apparatus needed is not expensive. The milk should first be run over a cooler and aerator of any of the common patterns and immediately placed in cans in a tank of cold water, or better still, ice water. The use of ice in the dairy is so essential and it can be obtained so cheaply in all parts of Michigan that there is no excuse for its absence. An ice house it not necessarily expensive and should form an adjunct to every dairy barn or milk house.

Where it is desired to ship milk to a distance with no treatment other than cleanliness and cooling, the method used by Mr. H. B. Gurler, of DeKalb, Ill., may be adopted to advantage.

The farm of Mr. Gurler is distant some 55 or 60 miles from Chicago, yet he finds it possible to supply a select trade in that city with fresh milk daily without pasteurizing. His method of treatment is thus described in his own language:

"As soon as the milk is obtained, it is run through a centrifugal machine, such as has been in use for some years in creameries, as a means of rapidly and economically separating the cream from the milk. I employ it for the purpose of separating from the milk any dirt or other solid matter which may have gotten into the milk in spite of the precautions previously used. Although in this operation the cream and milk are separated from each other, they are again mixed when they come from the separator and there is left behind in the machine a peculiar

mass of mucus, germs, etc., which it is very desirable to have out of the milk. Immediately after leaving the separator it is cooled to a temperature below 40 degrees Fahrenheit in hot weather and in some cases as low as 35 degrees Fahrenheit. This low temperature secured very quickly after milking is found to be very desirable as it improves the flavor and keeping quality of the milk. The milk is then bottled, each bottle stoppered with a wood pulp stopper, and a paper seal put over the top in such a manner that the contained milk cannot be reached unless the seal is destroyed. On each seal is stamped the date of bottling and my signature. This seal is a guarantee of genuineness to the customer. Although this process seems complex, it is in reality carried out quite readily by the trained workmen in my employ. Immediately after being sealed the bottles are packed in cases and put in a refrigerator where they are held at a temperature just above freezing until time for shipment when they are loaded in a refrigerator wagon and transported to the shipping station. This refrigerator wagon is used at all seasons, as it protects from cold as well as from heat. For use in hot weather I have cases with galvanized iron receptacles in the center which are filled with water and frozen solid by artificial cold. This enables me to deliver the milk in Chicago in the hottest weather in prime condition. I have an artificial refrigerating or ice making plant, which enables me to hold milk and cream at any desired temperature, from the time it is bottled until it is shipped. When desired by the consumer, the milk can be furnished pasteurized, that is to say, heated for ten minutes to a temperature of 167 degrees Fah. While this is further preventative of souring, it is not recommended, and is not necessary when proper care is taken of the milk after its receipt by the consumer."

This method has much to commend it in the case of a single herd, in which the cows are tuberculin-tested at least annually and are known to be free from disease and where the business is conducted on a scale large enough to warrant the use of expensive machinery.

Chemical Preservatives.—The use of all chemical agents in milk as a preservative is prohibited in most foreign countries and in some states of the Union. These chemical preservatives consist usually of some compound of boracic acid or salicylic acid. *They are all of them harmful to health and no honest man should use them.*

PRESERVING BY HEAT.

Boiling.—All of the adult bacteria found in milk and nearly all the spores are killed by boiling. Unfortunately heating the milk to the boiling temperature gives it a cooked taste which is highly objectionable to some people, while to others it is pleasant. It is impracticable, therefore, to recommend boiling milk indiscriminately as it would ruin it for general consumption. In a private family, however, where there is little or no dislike to the cooked taste the simplest and easiest way to treat the milk to render it perfectly safe from a biological standpoint, is to boil it. No thermometer or special apparatus whatever is then required. It is true that the proteid compounds may be rendered somewhat less digestible but the simplicity and certainty of the operation is an ample offset.

In families where the members are not accustomed to the use of the thermometer, simple boiling is by all means to be recommended. To pasteurize milk well requires careful manipulation of the milk and heat with constant attention for a period of at least a half hour. The sole superiority of the process over boiling is the absence of the cooked taste and the slightly greater digestibility. On the other hand in untrained hands there is the constant risk of not heating high enough or not holding the milk at the required temperature for the requisite time, when the attempt is made to pasteurize. No such risks exist when resort is had to boiling the milk. A double cooker like the one shown in Fig. 1 is well adapted to this purpose since the milk will not cook fast to the bottom of the inner vessel.

Fig.—1.

For the city family, therefore, which must receive milk from the general city supply the practice of invariably boiling the milk before using on the table or as the food of infants is to be unhesitatingly recommended. Milk so treated may be drunk with the assurance that it is conveying no infectious disease. Moreover, where a surplus must be carried over the night or longer in the warm weather of summer it will keep sweet and wholesome long after the untreated article would have spoiled. The milk should be kept after boiling in a covered vessel and in as cool a place as possible that it may not be contaminated with the germs which are always present in the air of the living rooms of the house.

REQUISITES TO PASTEURIZATION.

Where, however, the use of boiled milk is impracticable resort must be had to pasteurization, since this process rids the milk of noxious germs and leaves it free of foreign odor or taste.

1. To pasteurize successfully the milk must be as fresh from the cow as possible. If milk is allowed to stand the bacteria which it contains rapidly develop and lactic acid is one of the results, causing the milk to become sour. The germs which produce this lactic acid do not produce spores, it is true, and yield readily to a low temperature, but the presence of the acid itself causes the milk to curdle when heated, if the amount exceeds about .3 of a per cent.

The putrefying ferments and those that gain access to the milk from the filth of the stable reproduce largely through spores. If they are allowed to live, therefore, long in milk that fluid becomes strongly impregnated with spores which are resistant to the heat of pasteurization and may remain, after that process, to spoil the milk.

2. For the same reason the milk should have been handled in as cleanly a manner as possible to exclude dirt and undesirable bacteria.

3. To prevent the multiplication of such germs as have gained access to the milk it should be kept below 50 degrees Fah. from the time it is drawn from the cow until the pasteurizing process begins.

4. The milk should be heated rapidly to 155 degrees Fah. and after twenty minutes exposure to that heat it should be cooled with equal rapidity to below 50 degrees. To heat and cool suddenly is almost as important as to heat and cool at all. All of the different bacteria found in milk, including the germ of tuberculosis, are killed when the milk is kept at 155 degrees for twenty minutes. If the milk is brought slowly to that temperature opportunity is given while its temperature is in the region between 70 and 100 for the rapid multiplication of bacteria. Again, unless the milk is cooled rapidly the spores which it contains will germinate and revive the fermenting processes.

Dr. R. Lezé (La Laiterie, of Oct. 5 and 19, 1895), after emphasizing the necessity for making the rise and fall of temperature in the milk as nearly instantaneous as possible to prevent the vegetation of spores, speaks of another phase of the matter as follows: "Submitting these micro-organisms to temperatures very high at first and very low finally in rapid succession produces a destructive effect much more marked than would be accomplished by exposure to the same temperature applied gradually or progressively. This phenomenon is allied to the laws of acclimatization, which constitute one of the least known branches of zymotechnique. For example, a yeast plant will live through a passage from 50 to 159 degrees Fah. in temperature, or the reverse if the change is brought about slowly, but will be entirely destroyed by a rapid change from 50 to 140 degrees or from 140 to 32 degrees. It is this phenomenon which causes us to desire a sterilizer with a rapidity of action not realized in other kinds of apparatus."

On account of the necessity of this rapidity of action the vessels holding the milk must be made of material that will stand, without breaking, sudden and extreme changes in temperature. In our experiments we have found it practically impossible to use successfully glass fruit jars or bottles. They do not break while the milk is being heated but will not endure the necessary plunge into ice water immediately after the close of the exposure to heat. On the other hand tin cans of similar size and shape are unaffected by rapid changes in temperature. In the same article in "La Laiterie" Professor Lezé called attention to this fact. He says, "the method of pasteurizing milk in bottles is fundamentally defective. It is diametrically opposite to the rational application of heat. The heat should be applied quickly and the milk should be raised to the maximum temperature quickly to kill the microbes, and the cooling should be done with equal rapidity. In the heating and cooling of bottles precisely the opposite method takes place. It is necessary to heat and cool slowly on account of the molecular contraction of the glass which breaks the bottles."

Moreover, metal pails can be much more easily and thoroughly cleaned than can glass cans. Direct steam or boiling water can be turned on them without danger of breaking.

5. The milk must not be heated above 160°.

In our experiments with small quantities of milk we have found it possible to carry the temperature quite to 160°, to continue it there for

20 minutes and then by sudden cooling to 40° and below cause the cooked flavor to disappear after four or five hours. To guard against this cooked flavor it is necessary that the water surrounding the milk shall never be more than a degree or two higher than the maximum temperature to which the milk is heated. The use of steam or exposure of the vessel containing the milk to direct flame is of course not to be thought of.

6. Milk must be heated at least to 155°. The disease producing germs are killed possibly below this temperature but it is not wise to risk a less degree.

7. The air must be excluded from the milk after it reaches the pasteurizing temperature. The reason is obvious. The air of a dairy or living room is a fruitful source of bacterial infection. It must, therefore, be excluded by keeping the milk covered during pasteurization and afterwards.

8. The vessels containing the milk in the pasteurizing process and in which it is stored later must be absolutely clean and germ free. This perfection of cleanliness can be obtained by a thorough washing then rinsing in boiling water and finally if live steam is procurable, thorough steaming. Too much emphasis can not be laid upon this point. The apparatus used in the operation and the bottles in which the milk is to be transported must be *perfectly clean.* Bottles are hard to wash without proper apparatus but no pains should be spared to secure perfect cleanliness.

PASTEURIZING APPARATUS.

For Home Use.—In the Year Book of the U. S. Department of Agriculture for 1894, page 333, Dr. E. A. De Schweinitz recommends the following plan for pasteurizing milk in the household:

"Pasteurization can be easily carried on by any housewife. A simple and easy method is the one described in a circular issued by this bureau and which is here again printed:

"The simplest plan is to take a tin pail and invert a perforated tin pie plate in the bottom, or have made for it a removal false bottom perforated with holes and having legs half an inch high, to allow circulation of the water. The milk bottle is set on this false bottom and sufficient water is put into the pail to reach the level of the surface of the milk in the bottle. A hole may be punched in the cover of the pail, a cork inserted and a chemical thermometer put through the cork, so that the bulb dips into the water. The temperature can thus be watched without removing the cover. If preferred, an ordinary dairy thermometer may be used and the temperature tested from time to time by removing the lid. This is very easily arranged and is just as satisfactory as the patented apparatus sold for the same purpose."

Professor H. L. Russell, of Madison, Wisconsin, gives in bulletin 44 of the Wisconsin Experiment Station, page 17, the following directions for pasteurizing milk either for general or infant use:

1. Use only fresh milk (not more than 12 hours old) for this purpose.

2. Place milk in clean bottles or fruit cans, filling to a uniform level. (If pints and quart cans are used at the same time an inverted dish or piece of wood will equalize the level.) Set these in a flat bottom tin pail

and fill with warm water to same level as milk. An inverted pie tin punched with holes will serve as a stand on which to place the bottles during the heating process period.

3. Heat water in pail until the temperature reaches 160° F.; then remove from source of direct heat, cover with a cloth or tin cover and allow the whole to stand for half an hour.

4. Remove bottles of milk and cool them as rapidly as possible without danger to bottles and store in a refrigerator. * * * Milk treated in this way ought to keep perfectly sweet for several days.

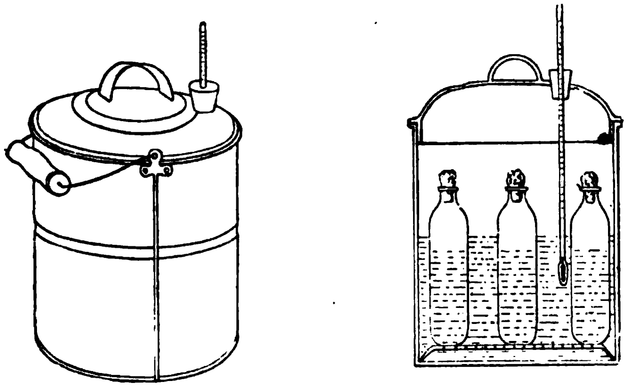

Fig.—2.

In all the essential particulars the apparatus described by Dr. Russell and Dr. De Schweinitz are identical. In our experience with this apparatus and with all others that use glass vessels to hold the milk we have found them inefficient for the reasons already given.

As a result of our experiments in the successful pasteurization of milk in small quantities we are ready to recommend that the milk be heated in tin pails rather than glass cans. Porcelain or agate ware is to be preferred to the tin as it will not rust from the condensed steam, but we have not found vessels of this ware of the desired shape in the market.

The form and arrangement of the apparatus is not essential.—We have found that a simple wash boiler filled with water up to a level with the surface of the milk in the cans to be treated, entirely satisfactory. Perforated pie tins in the bottom of the boiler keep the tin cans from coming in contact with the bottom of the boiler in immediate contact with the flame. The water is first raised to 160 degrees as indicated by a dairy thermometer floating in it, when the cans of milk are placed in it without covers and stirred at not infrequent intervals until they reach 155 degrees. The heat is so regulated that the water surrounding these cans does not meantime get hotter than 160 degrees. The temperature of the milk is occasionaly taken with the dairy thermometer, and when it reaches 155 degrees the covers are put on the cans and the boiler set on the back part of the stove or the gasoline flame turned down as low as possible. The cover is put on the boiler and left there continuously for twenty minutes except that the temperature of the water may be occasionally read to see that it does not exceed 160 degrees.

A tub of ice water is provided and at the expiry of twenty minutes from the time the milk in the cans reached the temperature of 155 degrees, the cans are removed from the boiler and plunged into the ice water. By repeated experiments we find that it requires less than 15 minutes to cool the milk to below 50 degrees when straight sided tin cans 3 inches in diameter and 7 inches deep were used.

After the milk has stood for a few hours the boiled taste very largely if not entirely disappears.

A kettle or a tin pail, covered or uncovered, will do to hold the water in which the smaller cans of milk are to be heated. A thermometer is of course absolutely essential, if it is desired to stop short of boiling. Too much emphasis cannot be laid upon the fact that no special form of apparatus is necesary to secure effective pasteurization. The milk can be treated in any sort of covered pail immersed in water in any sort of a kettle or boiler if they are clean. The kitchen and closets of every household contains utensils that can be readily adapted to the purpose. The purchase of expensive and intricate special apparatus for ordinary household pasteurization is unnecessary and is apt to lead to disappointment and the abandonment of the process altogether. The chief object of pasteurizing milk at home is to kill the germs of disease and this is accomplished in one form of apparatus as well as another if the entire mass of milk is kept at 155 degrees for the requisite time. Perfect exclusion of bacteria of the lactic acid group is not necessary or to be expected. *All utensils must be scrupulously clean.*

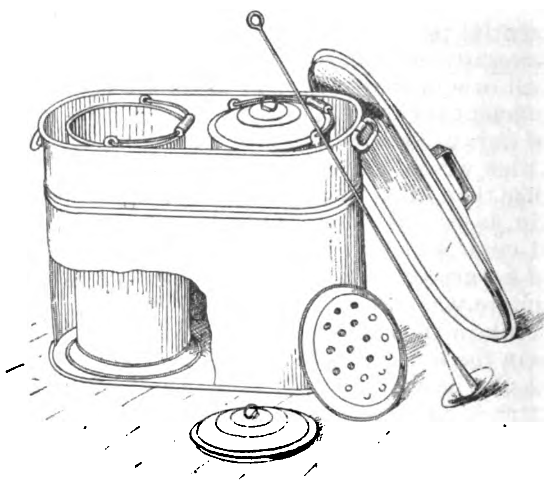

Fig.—3.

For hotels and large boarding houses we have tried no apparatus that gives more promise of cheapness, ease of management and efficiency than simple shot gun cans and a boiler made to order as high as the cans are deep and long enough to hold at least three of the cans. These cans are 8 inches in diameter and 22 inches deep, and hold conveniently 37 pounds of milk.

In our experiments we have heated the boiler, containing sufficient water to rise to the level of the surface of the milk in the cans after they are placed in it, on a gasoline stove to 160°. The cans of milk are then put in and the temperature of the water maintained by the flame below.

As soon as the cans have been heated the required twenty minutes, they are lifted from the boiler and plunged at once into ice water. We have used a deep wooden tank lined with galvanized iron to hold the ice water, the ice being pounded fine. On removal from the ice bath they may be placed in the refrigerator and left undisturbed until wanted for use. This apparatus is very cheap and effective. The accompanying cut illustrates the simplicity of the apparatus. The cans stand on inverted perforated pie tins. The stirring rod, standing at the end of the boiler, can be made by any tinsmith, and is used to keep the milk in motion while heating and again while cooling if the air of the room is pure and free from dust, to hasten the operation.

PASTEURIZING MILK FOR SALE.

The conditions to which milk must be subjected to kill the bacteria which it contains have already been named. A description of all the various kinds of apparatus in use in economically treating large quantities of milk, clearly does not lie within the scope of this preliminary bulletin. The pasteurization of milk, however, is no new thing either in the United States or in Michigan. The interest in the subject has been revived since the discovery of the transmissibility of diseases through milk. Various types of apparatus are in use to accomplish the desired end. To be economical the apparatus must be simple in construction, so that all parts may be easily reached and cleaned, and yet so arranged that the air can be excluded from the milk during the process of pasteurization and afterwards.

At Northville, Michigan, in the factory of the Clover Condensed Milk Co., a machine has been in successful operation for several years, which makes no attempt to exclude the air. On the contrary, during the whole process the milk is uncovered and exposed. *The machine itself, the room in which it is placed, the persons and clothes of the operators and the utensils which come in contact with the milk are kept most scrupulously clean.* The air which surrounds the milk is therefore free from odor and dust-laden bacteria.

Fig. 4 represents a section of this apparatus. It is built on the plan originated by Dr. De Laval and described in the valuable work on "Pasteurization and Milk Preservation," written and published by J. H. Monrad, Winnetka, Illinois, page 21. The machine, which is fifteen feet tall, consists of 56 saucer-shaped, hollow discs, 22 inches in diameter, placed one above the other. These discs are made of brass and so arranged that either steam or ice water may be turned into their interiors.

They are so shaped that as a continuous stream of milk flows upon the upper one it does not, when overflowing, drip from the outer edges, but follows the bottom surface well towards the center and reaches the disc below near the middle. When in operation, therefore, both the upper and under surfaces of all the discs are covered with a coat of milk.

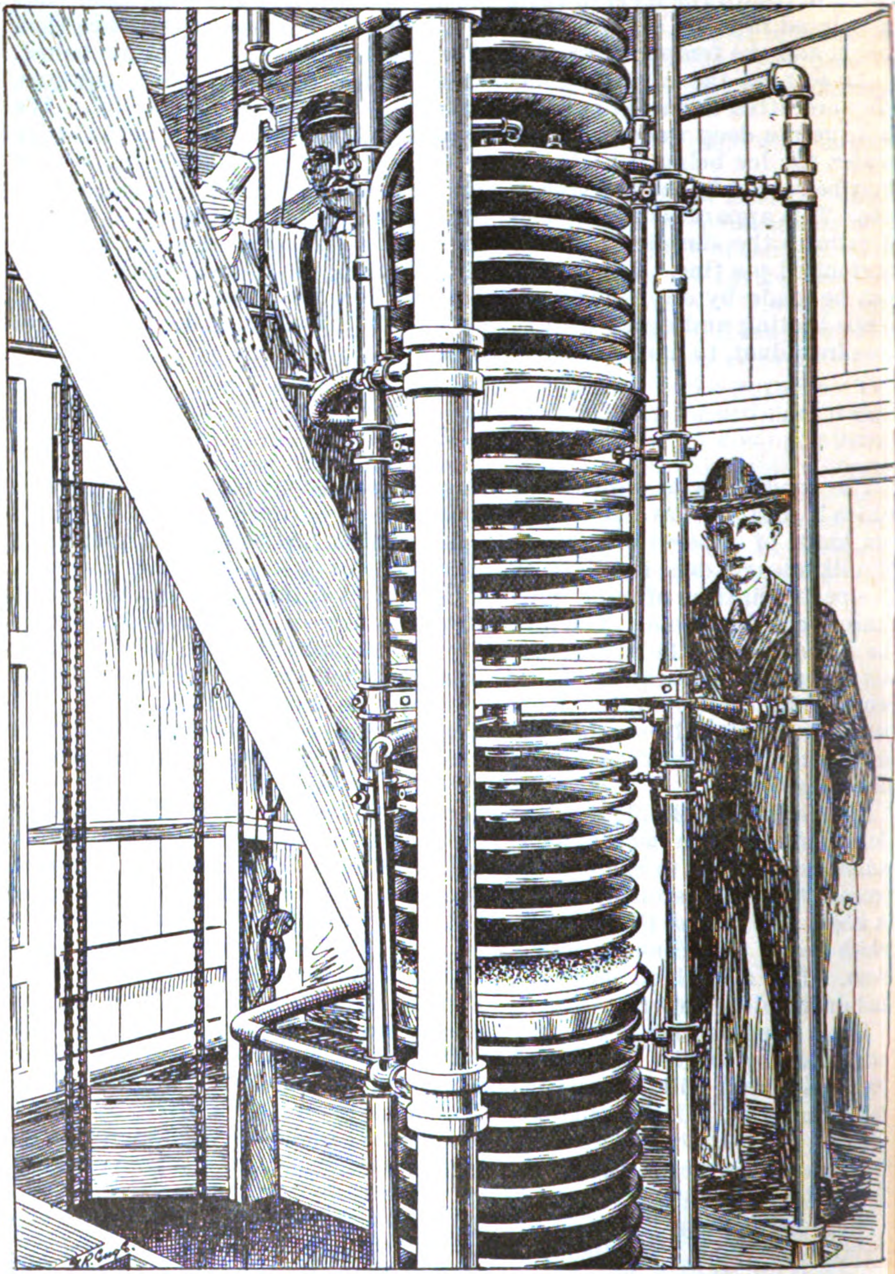

Fig.—4.

The interiors of the upper eight of these discs are connected with each other, forming the first set. The next eight form the second set and in a similar manner each disc forms one of a set of eight connected together. The upper eight discs are, when in operation, heated by steam to a temperature of 155 to 158 degrees. The set of eight discs immediately below is cooled by ice water admitted to the bottom disc and flowing out of the top one. The next eight discs are heated to 155 to 158 degrees and the one still below that is cooled. The heated and cooled sets of discs thus alternate from the top to bottom, except that the lower set of cooling discs contains sixteen instead of eight. In other words the milk that flows over the machine is heated three times to 155 degrees or over, and is in each case immediately cooled to about 60 degrees, except, since the bottom series of discs consists of sixteen, the milk is at last cooled to 50 or 56 degrees as it leaves the machine.

Beneath each series of discs to which steam is applied there is interpolated a reservoir for holding the milk a little longer at the pasteurizing temperature. This reservoir is made of tin and is shaped like a large milk pan, except that it is in three sections, each of which is a sector of a circle. The edges of the disc above this pan are made vertical so that the milk falls into the outer part of the pans. The milk empties into the disc below over the inner edges of the pans, which are just enough lower than the outer borders to cause a slow current toward the center.

It requires but a minute and a half for milk to run over the eight discs which constitute a heating set and thus become treated to 155°. The same time is required to cool it to 60 or below. It is then again almost instantly heated and again suddenly cooled. This is repeated three times. It is upon these sudden and extreme changes of temperature that the efficiency of the machine depends, since it has been shown that adult germs cannot withstand these extreme and sudden vicissitudes of temperature. By adjusting the flow of milk on one hand and of steam and ice water on the other, the temperatures can be regulated to a nicety.

From the last series of cooling discs the milk is run into a vat from which it is drawn into the bottling device and thence into the bottles in which it is transported to the city. These bottles have flat tops and are provided with tin covers beneath which, when the bottle is filled, a paper cap is inserted. The covers are held in place by a wire arrangement which, while holding the cover tightly in place during transportation is easily released by the consumer.

No biological examination has been made of the milk treated by this apparatus but the manager of the enterprise reports that the keeping quality of the milk is greatly increased and the product is giving entire satisfaction to a large and increasing list of patrons in Detroit. Samples of the milk tested at the College had neither odor nor taste of cooking. A history of these samples will illustrate the keeping qualities of pasteurized milk.

The bottles brought to the College were taken from the refrigerator at the Northville factory about two o'clock in the afternoon of the day on which the milk was pasteurized. They were then carried for two hours in the hot sun to a railroad station and from there to the College in the passenger coach of a railroad train, reaching the refrigerator of the dairy

room at the College at ten p. m., after eight hours exposure to the tropical heat of a summer afternoon.

One bottle was opened the following morning and found perfectly sweet with an acidity much less than found in samples of normal milk fresh from the cow tested at the same time. In the tests of milk for acidity a tenth normal solution of caustic soda is used. Fifty cubic centimeters of milk are measured into a beaker and a few drops of phenolphthalein added. The peculiarity of this substance is that it is colorless as long as the liquid in which it is in solution is acid but turns a vivid pink as soon as it becomes alkaline. The decinormal solution of the caustic soda is poured into a burette from which it can be slowly drawn and the quantity used accurately measured. The amount of the solution required to neutralize the fifty cubic centimeters of milk measures the sourness or acidity of the sample.

Using this test, it was found that the fifty c.c. of milk from the bottle opened the morning after its arrival at the College required but 10.2 c.c. of the decinormal alkaline solution to neutralize it, while a sample of normal milk fresh from the cow required in a parallel test, 14 c.c.

The second morning thereafter (the third morning after pasteurization) the milk in this bottle tested in the same way, required but 11.2 c.c. of the alkaline solution to neutralize the fifty c.c. of milk. Again, on the following morning, the fourth from the factory, the milk was still sweet, though requiring 14.6 c.c. of the alkaline solution when tested in the usual way. It had, however, "an old taste." The milk was kept in a refrigerator between these tests.

A second bottle brought from the factory in the same way and exposed to the summer heat for the same length of time as the first, was left in the refrigerator unopened until the morning of the fourth day after its delivery at the Experiment Station. It was found sweet and wholesome and free from objectionable odor or taste either of cooking or decay. It then required but 11.9 c.c. of the alkaline solution for neutralization. The morning following, the fifth from the factory, it was still sweet though evidently on the point of turning as it required 15.6 c.c. of the decinormal alkaline solution to neutralize the acidity of the fifty c.c. of milk.

These results are important as they show that the keeping quality of the milk had been very greatly increased by the pasteurization.

From a theoretical standpoint this apparatus is seriously defective in two points.

In the first place the milk is exposed to the air during the operation and thereafter until it is placed in the bottles. This difficulty is in part, if not wholly obviated, however, by making the machine the center of a small room which is kept scrupulously clean from dust. The operators, who must of necessity be continually passing in and out of the room to test the temperatures of the milk at the different points, are also clothed in clean and well ironed clothes so that no dust bearing bacteria fall from their persons. After cooling for the last time, the milk should be protected from exposure to outside air.

In the second place the milk is not kept at a pasteurizing temperature continuously for any considerable time. Practically the experience of this company and our examination of the products of their factory seem

to show that the net result of the treatment which the milk receives is satisfactory as far as the destruction of the lactic and putrefactive germs are concerned. We have made no examination of the milk for germs of disease. If care is used in the selection of the herds which supply the raw milk the danger from this source may be reduced to a minimum.

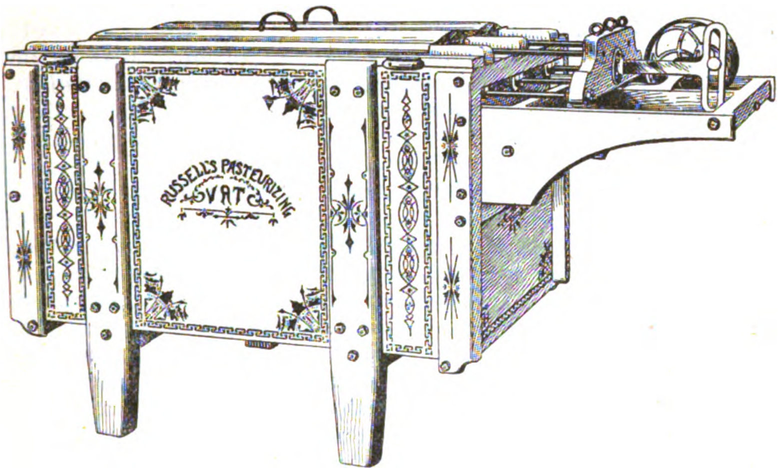

Fig.—5.

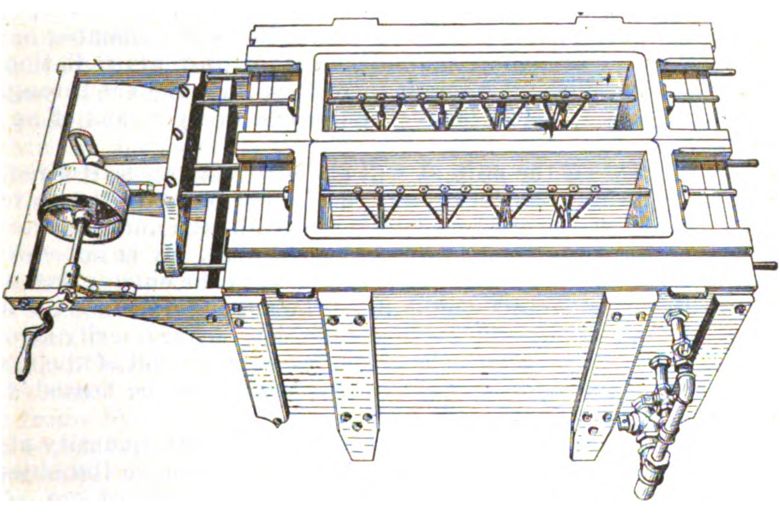

Fig.—6.

At the "Fair Oaks Farm" of E. O. Grosvenor at Monroe, Mich., an entirely different form of apparatus is used to pasteurize milk for the trade of the firm, Grosvenor & Mugg, in the city of Detroit. The accompanying cuts, Figs. 5 and 6, show its general features and most of

the essential parts. The two vats instead of being placed side by side, however, as shown in the cuts, are separated and placed one above the other and several feet apart. The milk is heated in the upper vat and drawn thence through a sterilized tube into the lower vat where it is cooled. The vats are porcelain lined. With these modifications the following description in the language of the inventor himself (Wisconsin Bulletin 44, pp. 27 to 30 inclusive), will apply to the apparatus on the "Fair Oaks Farm:"

"Where the output required exceeds many hundred pounds of material daily it is better to have the heater separate from the cooler so that both processes can go on simultaneously.

COMBINED PASTEURIZER AND COOLER.

This apparatus consists of two chambers; the inner, a milk reservoir, the outer a water jacket that encloses the milk chamber except on top. This inner chamber is a narrow, deep tin vat that is supported on both sides by a heavy wood strip which is fastened to the top of the tin reservoir and rests on the ends of the outer enveloping vat which is made of wood and unlined. This outer vat is about six inches larger than the inner one, thus affording an opportunity for a free circulation of water on all sides of the milk chamber except the top.

A steam pipe is introduced into the bottom of the water jacket and in this way, by having both steam and water connections, hot or cold water may be thrown into the outside vat. The pipes in the bottom are arranged so as to distribute the steam as much as possible. The milk chamber is covered by a simple tin cover having a single small perforation at one end that admits a thermometer. The water chamber has two wood covers on either side of the milk vat that prevents radiation to a considerable degree. Cold water is introduced into the vat through the steam pipe; it may be withdrawn through this or by means of an ordinary gate at one end of the vat.

In order to draw off the milk at will and still not expose it directly to the air, there is a brass outlet tube that is connected with the bottom of the milk chamber at one end and which passes though and projects some inches beyond the wooden wall of the outside vat. It is impossible to use an ordinary stop cock and have it attached to the outside free end of the outlet tube, because this would allow the milk to flow into the outlet tube to a point where the stop cock was placed. As ordinarily attached, this cut off would be several inches from the wooden end of the vat and the milk held in this space would consequently not be heated to the proper pasteurizing point.

It may be considered sufficient to withdraw a small quantity of milk at first and reject this, but this does not entirely remove the objectionable feature. There will remain even with this precaution a certain amount of bacterial life that will adhere to the walls of the outlet tube and will be washed off into the milk as the pasteurized fluid is withdrawn. Then, too, the outlet tube must be of a straight cylindrical bore so that a brush or some other cleansing arrangement can be introduced and pushed through from end to end. This cannot be done if an ordinary form of cock is inserted in the tube.

To overcome this difficulty we devised, with the co-operation of Professor C. I. King, of the Mechanical department of the University, a peculiar kind of stop cock that is placed in the outlet tube just inside the outer wall of the water chamber. This stop cock is arranged in such a way that when it is opened the orifice is equal to the inner diameter of the outlet tube. To the upper side of the cock is attached a long iron rod that reaches to the top of the vat and on the end of this, a lever is attached so that the stop cock can be easily operated from above. This arrangement enables the milk supply to be shut off at a point where the temperature can be controlled at will, and still it admits of perfect cleaning in all parts that come in actual contact with the milk.

In order to heat the milk quickly and uniformly, it is necessary to agitate the fluid in the inner chamber and in this way bring every particle in contact with the heating surface. If the water and the milk are both stirred, the heating or the cooling process can be very materially shortened, and in introducing a stirring apparatus, it is quite easy to adjust it so that both fluids can be kept in motion.

Not only does the agitation of the liquid permit of a more rapid elevation or diminution in temperature, but there is also less danger of overheating any part of the milk, and so causing the proteids to adhere to the walls of the vat. This movement of the milk in the inner chamber can be effected by a simple stirring device shaped something like a hoe and introduced under the cover at one end. One difficulty, however, is found in using such a contrivance, and that is the rubbing off of the tin plate on the bottom of the vat where the stirrer is brought in contact with it. This defect can be obviated in part by using a wooden implement instead of a metal one.

A much better device that can be used by hand or driven by machinery when desired, is the following one: To one of the machines is attached a frame that supports a movable eccentric gearing. The motive power is supplied by the revolution of an axle, and the arrangement of the eccentric is such that it permits a forward and back movement of the whole stirring machinery.

Into this frame is fastened three rods that run the whole length of the vat. The middle rod goes through the upper part of the milk chamber and to it are attached four wooden paddles that are nearly as long as the vat is deep. The lower half of two of these stirring paddles are made solid so as to cause an eddy in the milk or cream when it is stirred. In this way the cream is kept from rising to the top. The middle rod at least should be made of brass, as iron or steel rusts easily when exposed to the action of the steam in the milk chamber. It can be detached from the moveable frame by means of a pin, and in like manner the four paddles may each be removed at will. The outer rods pass over the water chamber on either side, and to each of these is firmly attached a wooden frame that is almost in contact with the outside of the milk vat. The frame that carries this series of rods with their stirring appendages is geared so that it slides back and forth for a distance of about eight inches, and by means of this the milk and water are kept in a state of constant motion. The continued renewal of the particles of milk and water that are brought in contact with the opposite surfaces of the metal wall of the milk chamber makes a rapid heating or cooling possible. Indeed, some sort of device

like this is necessary where the attempt is made to heat any considerable volume of milk.

The best results are secured if the water or steam is introduced through a perforated pipe that is arranged in such a way as to force the current along the side of the milk chamber instead of being diffused throughout the whole mass of water.

To aid in this a piece of galvanized sheet iron can be inserted in each water compartment. By means of this false partition the hot water is thrown upward along the milk vat, thus bringing it into direct contact with the surface cooled by the milk. This partition can be quickly removed when ice is added to assist in the cooling process. The agitators can be run by belt power or the axle may be revolved by means of a hand crank. But very little power is actually required to move the stirring machinery and the rate of agitation need not be more than twenty revolutions per minute.

The necessity of an automatic agitator may be questioned, but if the material is kept in constant motion, the length of time necessary to raise and lower the temperature properly will be much curtailed. Where milk is being heated no danger need be apprehended from stirring so that the employment of a mechanical device will release the time of the operator for other services.

Where cream is heated, there is, of course, danger of churning the material when the temperature falls to a point favorable for this process. The automatic device can be used continuously in the heating process, but if the cream is cooled in this same vat the stirring rod in the milk chamber should be disconnected when the temperature of the cream falls to the neighborhood of 70° F. This will prevent any churning and the movement of the outside water will materially hasten the fall in temperature. With the exception of the brass stop cock in the outlet tube, a vat of this character can be constructed by any good tinner and wood worker, and thus obviate the necessity of high priced patented apparatus.

PASTEURIZER OR HEATER.

The same principle can be applied in the construction of a vat that is designed especially for heating purposes. A few details should, however, be varied. The capacity of the outside water chamber can be materially diminished in a machine used exclusively as a heater. By diminishing the capacity of this reservoir considerable time and steam can be saved as it is not necessary to have a very thick layer of water to act as a cushion between the steam and milk.

Where it is desired to increase the capacity of the machine without unduly increasing the size of the apparatus, the milk vat may be made in two or more sections placed side by side as in Figures 5 and 6.

This will materially increase the superficial area of milk that is exposed to the heated water with the least possible increase in the size of the wooden vat. The agitation of the milk in these separate chambers may be done quite as easily as in a single vat.

COOLER.

Where moderate quantities of material, say from 500 to 1,000 pounds daily, are being handled, the cooling of the product can be done in the same vat in which the heating is carried on.

If larger quantities are pasteurized as is often the case where milk is handled, it is impractical to use a single vat as a heater and cooler. The alternate withdrawal of hot water and refilling with cold water for cooling and then the reheating of an equal amount for the next operation consumes too much time and is also expensive as to the amount of heat required for the process."

At the establishment of Mr. Grosvenor, where this apparatus is in use, an hour is required to heat 75 gallons of milk in the vat to 150°. It is kept at this temperature for 30 minutes when it is run into the vat below through a sterilized pipe where it takes from 25 to 30 minutes to cool it to 50° or below. In cooling the milk, water is used until the temperature falls to 85°, when pounded ice completes the cooling. Through another sterilized pipe the milk is drawn into a covered bottle filler from which the common sense bottles used in transporting the milk to the city are filled.

These bottles have flat tops into which pasteboard covers are fastened by paraffin.

The bottles of milk are shipped to the city on the day when pasteurized and sold the following morning. On the return of the bottles they are washed and rinsed very thoroughly and finally steamed for two or three hours in a metal lined room built for the purpose.

Other forms of apparatus are in use in the State, but enough has been written to give the reader a general understanding of the methods and apparatus used in pasteurizing milk on a commercial scale.

It must be remembered that pasteurized milk will spoil and sour just as raw milk does. That process is simply delayed and the period during which the milk is good for food, lengthened. It must therefore be kept in perfectly clean germ-free vessels; the air must be excluded by keeping the bottles covered, after they are opened for use, with an inverted glass if nothing better is at hand, and finally the milk must be kept as cool as possible.

MICHIGAN AGRICULTURAL COLLEGE,
June 1, 1896.

BACK NUMBERS OF BULLETINS.

Copies of the following Station Bulletins only are still on hand and will be sent to farmers free while they last, on application.

No. 65. Planting for Honey.
67. Fruit Tests at South Haven Station.
68. The Jack-pine Plains.
69. Feeding Steers of Different Breeds.
77. Comparing the Yield of Old Meadows with those Recently Planted.
78. Glanders and Farcy.
79. Vegetable Tests.
98. Locusts and the Horn Fly.
103. Peach and Plum Culture.
113–16. (In one volume.) Fattening Lambs. Rape as a Forage Plant. Management of Swamp Lands. Insects in the Clover Field.
117. Millet.
118. Fruits at South Haven.
119–20. Potatoes. Vegetable Novelties and Notions.
121. Pests of the Orchard and Garden.
122–24. Small Fruit Notes. Native Plums and Cherries. The Apple Orchard.
125. Crimson Clover and Other Topics.
126. Fertilizer Analyses.
127–28. Dairy Records. Fattening Lambs.
129–30. Fruits at South Haven. Fruits at the Agricultural College.

I. H. BUTTERFIELD,
Secretary.

ROBERT SMITH & CO., STATE PRINTERS AND BINDERS, LANSING.

BULLETIN 135

JULY, 1896

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

CHEMICAL DEPARTMENT

FERTILIZER ANALYSES.

BY R. C. KEDZIE,

CHEMIST OF THE EXPERIMENT STATION.

AGRICULTURAL COLLEGE, MICHIGAN
1896

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INSPECTION OF COMMERCIAL FERTILIZERS.

The law providing for the inspection and regulating the sale of commercial fertilizers was passed by the Michigan legislature in 1885, but did not "take effect" till ninety days after the final adjournment of that body. The law has thus been in operation for ten years. A retrospect of the workings of the law may not be out of place at this time.

One influence that assisted in the passage of the law was the demand of honest and reliable manufacturers for such a law to prevent the competition of unscrupulous dealers who offered for sale materials having very little value as fertilizers, in regard to which the farmer had no ready means of determining which was valuable and which valueless. Thus one manufacturer offered a mixture of soap-boilers' waste and leached ashes as a high grade superphosphate; another party shipped in from Ohio marl and offered it for sale as Buckeye phosphate. The college authorities were also desirous to screen the public from fraud. Our legislators readily saw the need of such a law when they found neighboring states requiring thorough inspection and regulation of sale, thus making our state a dumping ground for worthless fertilizers from other states.

The effect of the law has been to exclude worthless fertilizers from our state, or make their sale here very short-lived. Thus one party in a neighboring state shipped in nearly a thousand tons of ground furnace slag, mixed with a little salt, which they offered for sale at $20 a ton, and advertised the mixture in extravagant terms as a valuable fertilizer. When this wonderful compound, "Every pound made up of plant food," was analyzed and the farmers were informed that its real value as manure was only a few cents, they concluded not to pay the retail price of $22 a ton, and the sale suddenly stopped. The party came to Lansing breathing out threatenings of prosecution for damages in the sum of $50,000 unless the chemist would retract his statement in regard to the small value of this fertilizer. The bluff did not work and the threatened "suit in the United States court for exemplary damages in the sum of $50,000" has been postponed. It is pleasant to state that few such cases have come up.

Under the operation of this law there have been gathered in the open market and analyzed in ten years four hundred and ninety (490) samples of commercial fertilizers, from one hundred and forty-seven (147) manufactories. Of these total numbers, however, many are duplicated from year to year both as to specimens and manufactories. For example, a

firm sends into our market seven kinds of fertilizers every year, and these seven kinds and the firm are counted year by year in making up the list.

The first year under this law we had fifteen (15) kinds of fertilizers from six (6) manufacturers; this year, sixty-four (64) from sixteen (16) manufacturers. The larger part of the fertilizers came from Buffalo, Detroit, Chicago and Cleveland, in the order named.

WHAT FERTILIZERS SHALL BE INSPECTED?

This question is sometimes raised by dealers in fertilizers who claim that they sell for parties out of the state, who have neglected to take out a license which would cover all the retailers of the fertilizer in the state, that their sales are too small to justfy the expense for a license. The state law does not directly reach the manufacturers in other states and can only apply to parties in this state. If the manufacturer and wholesale dealer will not protect his customers in this state, they would do well to choose wholesale dealers who will look to the interests of their retail dealers. In any event it is necessary to protect the dealers who fully comply with the law, and this can only be done by impartially enforcing the law on all dealers.

Another party claims that his sales are too small to pay for a license; that he is attempting to establish a trade, and when the trade is established on a paying basis, the license will be taken.

In some states the license fee is based upon the number of tons of fertilizer sold during the year, but our law makes the license for the year the same whatever the amount sold. The law is explicit, requiring every fertilizer sold or offered for sale, the retail price of which exceeds $10 a ton, to be inspected and licensed before the sale is legal.

Another party claims that certain materials are chemical substances and are sold for other purposes than as fertilizers; such as nitrate of soda and muriate of potash. To exempt a material from the control of this law would throw out the phosphates, nitrates, the salts of ammonia, etc., because they are chemical substances and may be used for other purposes. But if any substance is offered for sale *as a fertilizer*, it plainly comes under the provisions of this law. It is just as important for the farmer to know how much potash is present in a Stassfurth salt, or the quantity of available nitrogen in nitrates and ammonia salts, as to be told how much of these materials is contained in mixed fertilizers. The farmer needs to know the quantity of useful materials present in the costly fertilizers offered for sale, whether in separate salts or in a mixture of materials, because the salts may vary in purity as well as compounds. It is plain that *every material offered for sale as a fertilizer should be inspected and licensed* if the price exceeds $10 a ton. The State Board of Agriculture has no power to modify or change the law, but it is its duty to enforce the law in such way as to protect both the farmer and the honest manufacturer.

If these foreign manufacturers are unwilling to place their goods in the open light of day by showing their real composition and thus come in fair competition with reputable dealers, it would be prudent for dealers to refuse to handle their goods, and thus save themselves from the severe penalty for selling unlicensed fertilizers. It would be wise for farmers to refuse to buy fertilizers whose composition they do not know,

and of whose intrinsic value they have no assurance. It would be well to leave such fertilizers severely alone. It is the manifest duty of the Board of Agriculture to enforce the law against the dealers in unlicensed fertilizers. When such dealer has paid a fine of $100 for the sale of an unlicensed fertilizer, he will conclude that there may be more profit in dealing in legitimate goods.

MANUFACTURERS SHOULD PROTECT THEIR RETAIL DEALERS.

By the proviso to section 3 of the law a dealer in this State is not required to take out a license for the sale of any fertilizer if the manufacturer has taken out a license for such fertilizer. In this way the manufacturer can protect all his agents in this State by payment of a single fee. Otherwise each dealer must take out a license. The object of the law is not merely to collect a revenue, but to secure the analysis and certification of every fertilizer sold in the State. If, then, any manufacturer neglects or refuses to take out a license for his goods, it would be a matter of prudence for all dealers to refuse his goods, and sell only the fertilizers of such manufacturers as will protect their agents in the State. If outside manufacturers neglect their State agents, then the law exacts the fee for license from each dealer in the State.

OBJECT OF INSPECTION OF COMMERCIAL FERTILIZERS.

The law does not prescribe any standard for the composition of a commercial fertilizer, the manufacturer being free to make his own standard, the law simply requiring that the fertilizers offered for sale shall be up to the standard set up by the manufacturer. The license to sell does not certify to the value of the fertilizer, but simply states that the manufacturer or dealer offers for sale a fertilizer for which a certain content of nitrogen, potash and phosphoric acid is claimed, and that samples of such fertilizers have been deposited with the secretary of the college with affidavit regarding the composition. Analysis is then made of each of these fertilizers, gathered in the open market as far as possible, and the results of such analysis published in bulletin. The *claimed* composition and *found* composition are arranged in parallel lines, so that the real composition can be compared at a glance with the composition claimed for it by the manufacturer. In this way the buyer can see at once by this bulletin whether the fertilizer is as good as the claims made for it.

ESTIMATION OF VALUES.

Severe criticism has been made of the effort to fix an estimate of money value of the leading materials that make up a mixed fertilizer, the value per pound of available nitrogen, phosphoric acid and potash. A word of explanation may not be out of place. It is manifestly impossible to fix prices upon these materials that would everywhere be just and proper, because they are not equally distributed and of uniform cost in all places.

The attempt has been made to fix a scale of prices in the Eastern States by finding the price of leading materials—bones, mineral phosphates, ammonia and potash—in such markets as New York and Phila-

delphia, and from such data to determine the average cost of the nitrogen, phosphoric acid and absolute potash they contain. In this way some approximate idea is formed of the commercial value of these materials. This, however, is not to be taken as expressing the *agricultural value*, or what cash profit the farmer will secure from their use.

WHAT TO LEARN FROM THE TABLE OF ANALYSIS.

As previously stated the three most valuable materials in commercial fertilizers are potash, phosphoric acid and available nitrogen. Each of these has a commercial value which may be stated in dollars and cents. Only these three substances are considered in the inspection of commercial fertilizers because the other materials are of too little value to be purchased at high prices. By placing before the farmer the composition as claimed by the manufacturer and the composition of the material as found in the market, he can find whether the goods are up to standard and can also form an estimate of the market value of the goods. If the analysis shows more of a given substance than is claimed, the goods are better than claimed; but if much less is found on analysis than is claimed, then the goods are proportionately of less value to the farmer.

The market value of these materials varies somewhat from year to year. The value of nitrogen estimated as ammonia is now 16 cents a pound; of available phosphoric acid, 8 cents a pound; of insoluble phosphoric acid, 2 1-2 cents a pound; and potash is worth 6 cents a pound.

Since there are 20 times 100 pounds in a ton, if we multiply the value of one pound by 20 we find the value of one per cent of any material in a ton. We may thus construct a table for estimating the value of any materials found in the results of analysis. One per cent means 20 pounds in a ton, and if the material is worth 8 cents a pound, then each per cent equals $1.60 for a ton.

Multiply the per cent	of	available P_2O_5 by	$1 60
"	"	insoluble P_2O_5 by	50
"	"	ammonia by	3 20
"	"	potash by	1 20

The sum of these products will give the market value of the fertilizer.

As this bulletin may fall into the hands of some who have never seen the law concerning the inspection of commercial fertilizers, the act is printed in full.

[Session Laws of 1885, No. 26.]

AN ACT to provide for the inspection of commercial fertilizers and to regulate the sale thereof.

Section 1. *The People of the State of Michigan enact*, That any person or persons who shall sell or offer for sale in this State any commercial fertilizer, the retail price of which exceeds ten dollars per ton, shall affix on the outside of every package containing such fertilizer a plainly printed certificate, stating the number of net pounds therein; the name or trade mark under which such article is sold; the name of the manufacturer, the place of manufacture, and a chemical analysis, stating the percentage of nitrogen in an available form; of potash soluble in water, and of phosphoric acid in available form (soluble or reverted) and the insoluble phosphoric acid.

Sec. 2. Before any commercial fertilizer is sold or offered for sale, the manufacturer, importer, or party who causes it to be sold or offered for sale within this State, shall file with the secretary of the State Board of Agriculture a certified copy of the analysis and certificate referred to in section one, and shall also deposit with said secretary a sealed glass jar containing not less than two pounds of such fertilizer, with an affidavit that it is a fair sample of the article thus to be sold or offered for sale.

Sec. 3. The manufacturer, importer or agent of any commercial fertilizer, the retail price of which exceeds ten dollars per ton as aforesaid, shall pay annually to the secretary of the State Board of Agriculture, on or before the first day of May, a license fee of twenty dollars for each and every brand of fertilizer he offers for sale in this State: *Provided*, That whenever the manufacturer or importer shall have paid this license fee his agents shall not be required to do so.

Sec. 4. All such analysis of commercial fertilizers required by this act shall be made under the direction of the State Board of Agriculture and paid for out of the funds arising from the license fees provided for in section three. At least one analysis of each fertilizer shall be made annually.

Sec. 5. The secretary of the State Board of Agriculture shall publish in his annual report a correct statement of all analysis made and certificates filed in his office, together with a statement of all moneys received for license fees, and expended for analysis. Any surplus from license fees remaining on hand at the close of the fiscal year shall be placed to the credit of the experimental fund of said board.

Sec. 6. Any person or persons who shall sell or offer for sale any commercial fertilizer in this State without first complying with the provisions of sections one, two, and three of this act, or who shall attach or cause to be attached to any such package or fertilizer an analysis stating that it contains a larger percentage of any one or more of the constituents or ingredients named in section one of this act than it really does contain shall, upon conviction thereof, be fined not less than one hundred dollars for the first offense, and not less than three hundred dollars for every subsequent offense, and the offender shall also be liable for damages sustained by the purchaser of such fertilizer on account of such misrepresentation.

Sec. 7. The State Board of Agriculture by any duly authorized agent is hereby authorized to select from any package of commercial fertilizer exposed for sale in this State, a quantity, not exceeding two pounds, for a sample, such sample to be used for the purposes of an official analysis and for comparison with the certificate filed with the secretary of the State Board of Agriculture and with the certificate affixed to the package on sale.

Sec. 8. All suits for the recovery of fines under the provisions of this act shall be brought under the direction of the State Board of Agriculture.

Approved March 10, 1885.

For the information of the public the fertilizers that have been inspected and licensed for 1896 are given in the following pages.

The gathering of specimens of commercial fertilizers in the open market for analysis, and the analytical work have for the most part been performed by Thorn Smith, Assistant in the Chemical Department of the Experiment Station, with the assistance of L. H. Van Wormer.

R. C. KEDZIE,
Chemist of Experiment Station.

AGRICULTURAL COLLEGE,
July, 1896.

Analysis of Commercial

Manufacturer.	Trade Name.	Dealer and Locality.
Armour & Co., Chicago, Ill.	Bone, Blood, and Potash	W. M. Cahow, Reading
Armour & Co., Chicago, Ill.	Bone Meal	Manufacturer
Armour & Co., Chicago, Ill.	Ammoniated Bone and Potash	John Sweitzer, Disco; W. M. Cahow, Reading
Armour & Co., Chicago, Ill.	All Soluble	E. A. Cunningham, Hillsdale; W. M. Cahow, Reading
Cleveland Dryer Co., Cleveland, Ohio	Ohio Seed Maker	E. W. Spencer, Petersburg
Cleveland Dryer Co., Cleveland, Ohio	Ohio Seed Maker with Potash	E. W. Spencer, Petersburg
Cleveland Dryer Co., Cleveland, Ohio	Buckeye Ammoniated Bone Superphosphate	E. W. Spencer, Petersburg
Cleveland Dryer Co., Cleveland, Ohio	Phosphate	E. W. Spencer, Petersburg
Cleveland Dryer Co., Cleveland, Ohio	Potato and Vegetable Fertilizer	E. W. Spencer, Petersburg
Crocker Chemical Co., Buffalo, N. Y.	Crocker's Ammoniated Bone Superphosphate	Seth Lathrop, Richmond
Crocker Chemical Co., Buffalo, N. Y.	Crocker's Ammoniated Wheat and Corn Phosphate	Manufacturer
Crocker Chemical Co., Buffalo, N. Y.	Crocker's Potato, Hop, and Tobacco Phosphate	Manufacturer
Crocker Chemical Co., Buffalo, N. Y.	Crocker's Special Potato Manure	Webster Cobb & Co., Charlotte; Joy & Owens, Albion
Crocker Chemical Co., Buffalo, N. Y.	Crocker's Superphosphate No. 2	Manufacturer
Crocker Chemical Co., Buffalo, N. Y.	Crocker's General Crop Phosphate	Smith & Tucker, Mt. Clemens

Fertilizers in Michigan, 1896.

	Available nitrogen.	Phosphoric Acid.			Potash Soluble in Water.	
	Estimated as ammonia.	Available P_2O_5.	Insoluble P_2O_5.	Total P_2O_5.	Estimated as K_2O.	Estimated as K_2SO_4.
Claimed	5 to 6	6 to 8		10 to 12	7 to 8	
Found	5.14	9.77	1.46	11.23	6.53	12.08
Claimed	3 to 4	10 to 14		25 to 28		
Found	4.01	14.96	7.55	22.51		
Claimed	3 to 4	4 to 6		8 to 10	1.5 to 2	
Found	3.34	8.15	1.53	9.68	1.37	2.53
Claimed	3.5 to 4.5	2 to 3		10 to 12	4 to 5	
Found	4.31	9.74	1.61	11.35	5.80	10.73
Claimed	1.5 to 2.5	10 to 12		15 to 17		
Found	2.57	10.25	3.50	13.75		
Claimed	1.5 to 2.5	10 to 12		15 to 17	2 to 3	
Found	2.31	7.27	5.37	12.64	2.83	5.24
Claimed	3 to 4	9 to 10		11 to 12	1 to 2	
Found	3.57	5.96	2.99	11.95	1.5	2.77
Claimed		13 to 15		15 to 17		
Found	.4	13.40	2.05	15.45		
Claimed	4 to 5	8 to 10		10 to 14	4 to 5	
Found	3.56	8.29	3.48	11.77	3.26	6.08
Claimed	3.5 to 4.5	10 to 12	1 to 2	11 to 14	1.08 to 2.	2 to 3
Found	3.95	11.07	1.41	12.48	1.36	2.42
Claimed	2.5 to 3.5	10 to 13	1 to 2	11 to 15	1.6 to 2.7	3 to 5
Found	2.75	9.52	.79	10.31	2.19	4.05
Claimed	2.5 to 3.5	10 to 12	1 to 2	11 to 13	3.25 to 4.30	6 to 8
Found	2.56	9.85	1.23	11.08	3.67	6.79
Claimed	4.5 to 5.5	8 to 9	1 to 2	9 to 11	5.4 to 6.4	10 to 12
Found	4.66	8.26	1.82	10.08	5.3	9.80
Claimed		11 to 13	1 to 2	12 to 15	1.35 to 2.	2.5 to 3.5
Found	.12	10.92	1.87	12.79	1.42	2.63
Claimed	1 to 2	7 to 10	1 to 2	8 to 12	1.08 to 2.5	2 to 4
Found	1.25	7.75	2.69	10.44	.94	1.74

Analysis of Commercial

Manufacturer.	Trade Name.	Dealer and Locality.
Crocker Chemical Co., Buffalo, N. Y.	Crocker's Universal Grain Grower	Joy & Owens, Albion
Crocker Chemical Co., Buffalo, N. Y.	Crocker's New Rival Ammoniated Superphosphate	Webster, Cobb & Co., Charlotte
Crocker Chemical Co., Buffalo, N. Y.	Crocker's Practical Ammoniated Superphosphate	Manufacturer
Crocker Chemical Co., Buffalo, N. Y.	Crocker's Vegetable Bone Superphosphate	Webster, Cobb & Co., Charlotte; F. O. Chevey, Kalamazoo
Crocker Chemical Co., Buffalo, N. Y.	Crocker's Ground Bone Meal	Joy & Owens. Albion
James Boland, Jackson, Mich.	Blackman Fertiliser	Manufacturer
Darling & Co., Chicago, Ill.	Pure Ground Bone	Manufacturer
Darling & Co., Chicago, Ill.	Chicago	Manufacturer,
Darling & Co., Chicago, Ill.	Sure Winner	Manufacturer
Darling & Co., Chicago, Ill.	Farmers' Favorite	Manufacturer
Darling & Co., Chicago, Ill.	Vegetable Grower	Manufacturer
Darling & Co., Chicago, Ill.	Darling's Odorless Lawn Dressing	Manufacturer
W. S. Dunbar, St. Joseph, Mich.	Meat and Bone	Manufacturer
Grand Rapids Glue Co., Grand Rapids, Mich.	Non Plus Ultra	Perkins & Hess, Grand Rapids
Great Eastern Fertilizer Co., Rutland, Vermont	Corn Fertilizer	G. R. Lovejoy, Lenox
Great Eastern Fertilizer Co., Rutland, Vermont	Vegetable, Vine, and Tobacco Fertilizer	Manufacturer
Great Eastern Fertilizer Co., Rutland, Vermont	Soluble Bone and Potash	Manufacturer

Fertilizers in Michigan, 1896.

	Available nitrogen.	Phosphoric Acid.			Potash Soluble in Water.	
	Estimated as ammonia.	Available P_2O_5.	Insoluble P_2O_5.	Total P_2O_5.	Estimated as K_2O.	Estimated as K_2SO_4.
Claimed Found	1 to 2 1.42	7 to 10 6.17	1 to 3 3.63	8 to 13 9.80	2.7 to 4 4.39	5 to 7 8.12
Claimed Found	1.5 to 2.5 1.78	10 to 12 10.34	1 to 3 2.53	11 to 15 12.87	1.6 to 3 1.76	3 to 5 3.26
Claimed Found	1 to 2 1.41	8 to 10 7.42	1 to 2 4.45	9 to 12 11.87	1.08 to 2 1.47	2 to 3 2.72
Claimed Found	6 to 7 6.14	6 to 7 6.56	1 to 2 .64	7 to 9 7.20	5.94 to 8 6.50	11 to 15 12.02
Claimed Found	2.5 to 4 2.44	....	....	25 to 28 25.99	....	....
Claimed Found	1.06 1.03	5.38 4.45	1.31 1.77	.... 6.22	.27 .23	.... .48
Claimed Found	3 to 4 3.55	8 to 9 14.23	15 to 16 9.26	.... 23.49	....	....
Claimed Found	2 5 to 3 2.7	7 to 9 9.09	4 to 5 3.68	.... 12.77	1 to 2 1.99	.... 3.68
Claimed Found	1.5 to 2 5 2.37	7 to 9 8.52	4 to 5 3.15	.... 11.67	3 to 4 3.65	.... 6.15
Claimed Found	3.5 to 4.5 4 78	8 to 9 9.28	5 to 5.5 4.20	.... 13.48	4 to 5 4.18	.... 7.73
Claimed Found	4 to 5 4.23	7 to 9 8.21	1 to 2 2 97	.... 11.18	7 to 9 7.66	.... 14.17
Claimed Found	3 to 4 4.49	8 to 9 8.26	2 to 3 1.92	.... 10.18	3 to 4 5.06	.... 9.36
Claimed Found	.... 6.10	.... 4.03	.... 1.94	.... 5.97	....	....
Claimed Found	4.48 to 5.30 4.45	....	.... 1.46	17 to 22 6.62	....	....
Claimed Found	1 to 2 2.54	8 to 10 8.83	1 to 3 .51	.... 9.34	4 to 6 4.56	.... 8.44
Claimed Found	2.5 to 3.5 2.82	8 to 12 9.67	1 to 3 1.25	.... 10.92	3.5 to 4.5 3.56	.... 6.59
Claimed Found	.... .34	11 to 13 11.89	.... .95	.... 12.84	2 to 4 1.40	.... 2.59

Analysis of Commercial

Manufacturer.	Trade name.	Dealer and locality.
Great Eastern Fertilizer Co., Rutland, Vermont	English Wheat Grower	Manufacturer
Great Eastern Fertilizer Co., Rutland, Vermont	Dissolved Bone	G. B. Lovejoy, Lenox
S. M. Isbell & Co., Jackson, Mich.	Isbell's Celery Grower	Manufacturer
Iron Cliffs Co., Negaunee, Mich.	Bone Meal	Manufacturer
Jarecki Chemical Co., Sandusky, O.	Fish and Potash Potato Food	J. H. McMann, Richmond
Jarecki Chemical Co., Sandusky, O.	Lake Erie Fish Guano	J. H. McMann, Richmond; C. Godfrey & Co., Benton Harbor
Lister's Agricultural Chemical Works, Newark, New Jersey	Lister's "Success" Fertilizer	P. P. Andrews, Washington
Lister's Agricultural Chemical Works, Newark, New Jersey	Lister's Special Potato Fertilizer	Manufacturer
Michigan Carbon Works, Detroit, Mich.	Dessicated Bone with Potash	B. F. Pixley, St. Joseph
Michigan Carbon Works, Detroit, Mich.	Homestead Potato Grower	B. F. Pixley, St. Joseph; J. H. Farnum, Kalamazoo
Michigan Carbon Works, Detroit, Mich.	Homestead Vegetable Grower	O. E. Thompson, Ypsilanti; J. H. Farnum, Kalamazoo
Michigan Carbon Works, Detroit, Mich.	Homestead, a Bone Black Fertilizer	John Griffiths, Three Rivers; F. McIntyre, Mt. Clemens
Michigan Carbon Works, Detroit, Mich.	Dessicated Bone	B. F. Pixley, St. Joseph
Michigan Carbon Works, Detroit, Mich.	Perfection Fruit Grower	J. H. St. John, Utica; J. H. Farnum, Kalamazoo
Michigan Carbon Works, Detroit, Mich.	Jarvee Drill Phosphate	J. Bartholomew, Romeo
Joseph Lister, Chicago, Ill.	Raw Ground Bone	C. H. Farnum
Niagara Fertilizer Works, Buffalo, N. Y.	Niagara Wheat and Corn Producer	McKay & Stafford, Romeo; Allen & Henry, Reading

Fertilizers in Michigan, 1896.

	Available nitrogen.	Phosphoric acid.			Potash soluble in water.	
	Estimated as ammonia.	Available P_2O_5.	Insoluble P_2O_5.	Total P_2O_5.	Estimated as K_2O.	Estimated as K_2SO_4.
Claimed	1 to 2	8 to 12	1 to 3		2 to 4	
Found	1.35	5.79	3.55	9.34	2.21	4.09
Claimed		13 to 17				
Found		12.76	2.10	14.86		
Claimed	2 to 3			8 to 9	10 to 12	
Found	3.16			16.17	10.35	19.15
Claimed	4.20			23.		
Found	4.93			23.26		
Claimed	2 to 3	6 to 7	1 to 2		3.5 to 4	
Found	2.30	10.44	1.00	11.44	5.51	10.19
Claimed	2 to 3	10 to 12	1.5 to 2		1 to 2	
Found	1.00	13.12	2.81	15.93	.52	.96
Claimed	1.24 to 1.65	9.5 to 11	2 to 3		2 to 3	
Found	1.94	9.05	3.20	12.25	2.11	3.90
Claimed	2 to 3	8 to 10			3 to 4	
Found	2.25	8.23	2.69	10.92	2.68	4.96
Claimed	1.25 to 2.25			25 to 30	1.5 to 2.5	
Found	2.03			27.60	3.55	6.57
Claimed	1.94 to 2.68	8.5 to 10	.5 to 1.5	9 to 11.5	5 to 6	
Found	2.50	9.23	1.51	10.74	4.64	8.58
Claimed	4.6 to 5.35	5 to 6.5			6.5 to 7.5	
Found	6.70	7.61	.59	8.20	5.93	10.97
Claimed	1.85 to 2.40	8 to 11	.5 to 1.5	8.5 to 12.5	1.5 to 2	
Found	2.13	9.07	1.82	10.89	2.20	4.07
Claimed	1.5 to 2.5			25 to 30		
Found	1.8			29.58		
Claimed	.8 to 1.25	10 to 11	1 to 2	11 to 13	7 to 8.5	
Found	1.21	12.62	1.66	14.28	6.76	12.54
Claimed	1.25 to 2	8 to 9			.75 to 1.25	
Found	1.45	8.64	.95	9.59	1.02	1.86
Claimed	4 68	25.60				
Found	3.30			24.56		
Claimed	1.5 to 2.5	8 to 10	1 to 2		2.16 to 3.24	4 to 6
Found	2.40 → 1.61	7 22	2.40	9.62	2.7	4.99

Analysis of Commercial

Manufacturer.	Trade name.	Dealer and locality.
Niagara Fertilizer Works, Buffalo, N. Y.	Niagara Triumph	Seth Lathrop, Richmond
Niagara Fertilizer Works, Buffalo, N. Y.	Niagara Grain and Grass Grower	Allen & Henry, Reading
Niagara Fertilizer Works, Buffalo, N. Y.	Niagara Potato, Tobacco and Hop Fertilizer	Manufacturer
Northwestern Fertilizing Co., Chicago, Ill.	Potato Grower	Henry Rupert, Battle Creek
Northwestern Fertilizing Co., Chicago, Ill.	Challenge Corn Grower	Manufacturer
Northwestern Fertilizing Co., Chicago, Ill.	Pure Ground Bone	Henry Rupert, Battle Creek
Northwestern Fertilizing Co. Chicago, Ill.	Fine Raw Bone	Manufacturer
Northwestern Fertilizing Co., Chicago, Ill.	Garden City Superphosphate	D. H. Cunningham, Reading; Henry Rupert, Battle Creek
Northwestern Fertilizing Co., Chicago, Ill.	Prairie Phosphate	Manufacturer
Northwestern Fertilizing Co., Chicago, Ill.	Raw Bone and Superphosphate Mixture	Manufacturer
Speidel Swartz & Co., Grand Haven, Mich.	Celery Hustler	N. Robbins, Grand Haven

The following Fertilizers found on sale have not been licensed and the sale as fertilizers is illegal:

Fitch Fertilizer Co , Bay City, Mich.	*Bone Meal	Manufacturer
Fitch Fertilizer Co., Bay City, Mich.	*Big Crop Phosphate	Manufacturer
Detroit Sanitary Works, Detroit, Mich.	*Clover Leaf	E. R. Smith & Co., Birmingham
Swift & Co., Chicago	*Swift's Raw Bone Meal	Alfred J. Brown Co., Grand Rapids

* Not licensed. Sale unlawful. See Sec. 6 of the law.

Fertilizers in Michigan, *1896.*

	Available nitrogen.	Phosphoric acid.			Potash soluble in water.	
	Estimated as ammonia.	Available P_2O_5.	Insoluble P_2O_5.	Total P_2O_5.	Estimated as K_2O.	Estimated as K_2SO_4.
Claimed	3 to 4	8 to 10	1 to 2		2.16 to 3.24	4 to 6
Found	3.49	7.16	2.40	10.56	2.98	5.51
Claimed	1 to 2	7 to 9	1 to 2		1.08 to 2.16	2 to 4
Found	1.40	7.24	3.61	10.85	1.48	2.74
Claimed	2 to 3	8 to 10	1 to 2		2.70 to 3.78	5 to 7
Found	2.43	7.99	1.23	9.21	2.80	5.18
Claimed	3 to 4	7 to 9				4 to 5
Found	3 46	6.49	4.22	10.71	2.58	4.77
Claimed	2.5 to 3.5	8 to 9				1 to 2
Found	3.14	9.87	.59	10.46	1.21	2.24
Claimed	3 to 4			18 to 22		
Found	4 05			17.77		
Claimed	4 to 5			22 to 24		
Found	5.12			19.70		
Claimed	2.5 to 3	8 to 9	4 to 4.5		.054 to 1.08	
Found	3.02	7.48	3.50	10.98	.95	1.76
Claimed	2 to 2.5	6 to 8	3 to 4			
Found	2.61	7.57	3.79	11.36		
Claimed	3 to 3.5	7 to 8				1 to 2
Found	4.32	8.54	4.02	12.16	.85	1.57
Claimed	9 60	2.93	.74	3.67	1.1 to 2.08	
Found	7.84	3.17	.69	3 86	1.27	2.35

BULLETINS 136, 137, 138 NOVEMBER, 1896

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

FARM DEPARTMENT.

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136. FATTENING LAMBS—A Comparison of Fodders.

137. FEEDING CORN SMUT.

138. PIG FEEDING.

AGRICULTURAL COLLEGE, MICHIGAN
1896

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OF THE

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To H. W. MUMFORD,
Agricultural College, Mich.

J. L. SNYDER,
President of the College.

BULLETINS 136, 137, 138 SEPTEMBER, 1896

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

FARM DEPARTMENT

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136 FATTENING LAMBS—A COMPARISON OF FODDERS

137 FEEDING CORN SMUT

138 PIG FEEDING

AGRICULTURAL COLLEGE, MICHIGAN
1896

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

MICHIGAN AGRICULTURAL EXPERIMENT STATION

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Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.

FATTENING LAMBS.—A COMPARISON OF FODDERS.

BY HERBERT W. MUMFORD.

CONTENTS.

SUMMARY.

1. Lambs can be profitably fattened without clover hay.

2. Under the conditions existing in this experiment a pound of gain was most economically produced where a ration of corn, roots and corn stalks was fed. With this ration a pound of gain cost 3.58 cents. The average cost of a pound of gain in all the lots was 4.53 cents. The cost of a pound of gain was the least where corn stalks was the fodder ration, and greatest where millet hay was the fodder ration.

3. The number of pounds of dry matter required to produce a pound of gain was least where corn stalks and clover hay was the fodder ration, and greatest where millet hay was the fodder ration.

4. Since the buying and selling prices are important factors of the profit and loss account, it would be well to note that the lambs used in this experiment were purchased at 2.37 cents per pound, and sold at 4.6 cents per pound.

5. From the standpoint of the dry matter required to produce a pound of gain, the results go to show that where clover hay was fed *with some other fodder* it required less pounds of dry matter to produce a pound of gain than where the other fodder was fed alone. This advantage is not attributed to the clover hay but to the variety in the ration, for by referring to Table III it will be noticed that it required less pounds of dry matter to produce a pound of gain where corn

stalks and alfalfa were fed alone than it did where clover hay was fed alone; and again, it took fewer pounds of dry matter to produce a pound of gain with clover hay and corn stalks than it did with either alone as the fodder ration.

6. To show that all the lambs were well fattened the following letter from the commission firm in East Buffalo, who sold the lambs for the Lansing parties who purchased them of the Station might be of interest:

"East Buffalo, *Feb'y 19, 1896.*

"Jones and Brumm, *Lansing, Mich.:*

"Messrs—The only fault with this lot of lambs is that they are too heavy. It has been almost impossible to sell heavy lambs; several loads of good ones have been lying around here for a week unsold. This lot of yours sold fully one-fourth higher than the same kind and weight was selling at. Sheep may be called steady and lambs a shade higher, due more to snow storm which is likely to shorten the supply.

"Swope, Hughes, Waltz & Benstead."

7. The results of this set of experiments show that any of the following fodders may be substituted in the ration of fattening lambs in the place of clover hay:

1. Alfalfa. By feeding to each lamb an average of 1.3 pounds of alfalfa per day, with corn and roots, the lambs so fed gained an average of 2.45 pounds per week, or 34.4 pounds during the whole period of 14 weeks. This lot made a little better gain than any other lot in the experiment.

2. Millet hay. More care is necessary in feeding millet hay to fattening lambs than any other coarse fodder. Unless fed in small quantities it induces scours. Each lamb in the lot receiving millet hay was fed an average of .9 of a pound per day throughout the feeding period and gained 25.8 pounds per lamb.

3. Oat straw. Lambs fed on oat straw as the fodder part of the ration consumed an average of 1.25 pounds per lamb per day. The average total gain of each lamb was 28.5 pounds or 2.03 pounds per week. The results of this experiment seemed to indicate that the value of oat straw in the fodder ration of fattening lambs has been hitherto underrated.

4. Corn stalks. The principal objection to feeding corn stalks to lambs is that when fed in the bundle from racks, the lambs waste a large per cent of the fodder. The only satisfactory method of feeding them is in racks after they have been cut in a cutting box or ensilage machine. The stalks fed in this experiment were cut with an ordinary ensilage cutter and fed from racks. The average daily ration of this fodder was 1.18 pounds for each of the 10 lambs. Each lamb in the lot receiving corn stalks as the fodder ration gained an average of 2.15 pounds per week or 30.2 pounds for the whole period. Such flattering results should make every sheep feeder value his corn stalks highly, and induce him to take every possible precaution to properly preserve them.

5. Bean straw. This experiment substantiates a general opinion that bean straw is a good substitute for clover hay. An average feed of 1.33 pounds of bean straw, together with the roots and corn, produced an average gain of 2.11 pounds per day for 14 weeks or a total gain of 29.6 pounds for each lamb.

INTRODUCTION.

For several years the supply of clover hay in Michigan has been gradually diminishing on account of the repeated dry seasons and the ravages of the insect enemies of the clover plant, necessitating whenever possible the substitution of other fodders in the rations of live stock. Farmers have become at times greatly concerned lest they should be obliged to abandon further attempts to grow clover in Michigan. While it has been generally conceded that there is no fodder that can altogether take the place of well cured clover hay in the ration of fattening sheep and lambs, experiments in fattening sheep with but little clover hay or possibly none cannot fail to be timely.

Those who have had experience in fattening both old sheep and lambs will know that it is much easier to fatten the former than the latter without clover hay. Many experienced feeders have gone so far as to say that it is not possible to successfully fatten lambs without clover hay. With these ideas in mind the general plan of the experiments with fattening lambs during the season of 1895 and 1896 was outlined.

One hundred grade Shropshire lambs were purchased in the vicinity of the Agricultural College. These lambs were very ordinary individuals, no better than the average lambs which can be picked up in almost any section in the State. They were delivered at the College on or before August 20, 1895. From that time until September 3d, they were kept on an ordinary pasture of mixed grasses. On the third day of September they were turned on a field of rape after being weighed. The field of rape was good during the early part of September but the very dry weather of the latter part of that month and early October furnished just the conditions favorable to the growth and reproduction of plant lice which did serious damage to the rape. As a result the gains made were less than those secured from equal areas of rape in previous years at this station and elsewhere.

One hundred and thirty-five sheep were pastured on the seven measured acres of rape for 8 weeks during which time they gained an average of 8 pounds per head or 1 pound each per week. Heretofore the gains per lamb per week on rape have been from 2 to 3 pounds. As stated before the differences in gain made in different seasons were due most probably almost wholly to the lice on the rape plant.

GENERAL PLAN OF THE EXPERIMENT.

The lambs were divided into 10 pens of 10 lambs each. This work was very carefully done, the lambs in each pen being selected so that they would correspond in size and thrift with those in the other pens.

No effort was made to compound rations with a definite nutritive ratio. One pen was taken as a basis or standard for comparison. This standard pen was fed a ration of corn, roots and clover hay, the ration which has given the best results in previous seasons. As the aim was to determine the relative value of certain of our common fodders for fattening lambs, the nine other pens were fed either alfalfa, millet hay, oat straw, corn stalks or bean straw. Corn was chosen as the grain feed for all the lots.

Since the feeding of roots for fattening lambs at this station has been attended with good results in the past they were included in the ration of each lot. It is desirable and at times even necessary to use some clover hay and supplement this with other coarse fodders. Moreover, it has been believed by a large number of sheep men that, to secure the best results in caring for and fattening sheep, it is necessary to furnish considerable variety in food stuffs. It was thought therefore not only an interesting but important line of investigation to observe results where clover hay was fed in connection with other coarse fodders. Lambs will not eat any considerable quantity of other coarse fodders if they receive all the clover hay they want even if the clover hay is fed but once a day. Consequently the amount of clover hay fed in conjunction with the other fodders was limited as nearly as possible to half the amount fed to the standard pen or lot.

MANNER OF FEEDING.

The lambs were fed in the experimental feeding barn described on page 48 of bulletin No. 128. The feed troughs and racks were thoroughly cleaned out the first thing in the morning, and the lambs were fed their ration of corn about 6:30 a. m. As soon as the corn was eaten up the hay or other coarse fodder was put in the rack and fresh water provided. At 12:30 p. m., their allotted portion of roots was fed and at 4:00 p. m. corn, fodder and water were given in the same order as in the morning. During the ten days previous to the beginning of the experiment proper, the lambs were fed the same foods that they were to receive during the experiment and in the same manner; this period was designated as the preliminary feeding period. The lambs were weighed on three consecutive days at the beginning of the experiment and the average of these weights was taken as the true weight, thus largely doing away with the source of error in weight caused by differences in bowel contents.

FOOD STUFFS AND PRICES.

Somewhat peculiar conditions existed last winter in regard to the prices of food stuffs. Prices for corn ruled low while fodder of all kinds was high. The prices given below conform as nearly as may be to those current in this section of the State during the feeding period. The clover hay was of average quality. The roots were grown on the College farm and were ruta bagas. The corn was yellow dent grown on the College farm. A portion of the millet hay used was also grown on the College farm and the remainder purchased of a farmer living near the College. The

oat straw, corn stalks and bean straw were of average quality. It was found that the lambs wasted a large amount of corn stalks when they were fed in racks from the bundles. They were therefore cut in pieces from 1½ to 3 inches in length with an ordinary ensilage cutter.

Cost of Food Stuffs.

Corn, 30c. for 56 lbs. or	$10 71	per ton.
Roots, (ruta bagas)	2 50	" "
Clover hay	12 00	" "
Alfalfa	12 00	" "
Millet hay	10 00	" "
Oat straw	6 00	" "
Corn stalks	3 00	" "
Bean straw	7 00	" "

WEEKLY RECORDS OF FEED, WEIGHT AND GAIN.

These tables show the weight of lambs at the end of each week, the amount of the different foods consumed each week and the cost of these food stuffs. The amount of water drank is also shown. The totals at the bottom of the tables show at a glance the total food consumed during the feeding period. Each pen of lambs was weighed Monday mornings at 7:30 o'clock, water having been withheld about 14 hours previous to this time. The lambs were fed their corn before being weighed but no fodder.

EXPLANATION OF FINANCIAL STATEMENT.

The financial statement accompanying each lot is not altogether complete, as no account is there taken of the labor necessary to care for the lambs or of the valuable fertilizer produced in the form of sheep manure. With these exceptions, however, the financial statement is correct. The reader is cautioned to very carefully study the contents of this bulletin before drawing conclusions. Results shown in certain parts of this bulletin if taken alone might prove misleading, but by carefully studying the bulletin as a whole this source of error may be avoided.

LOT 1. (10 Lambs.)

Weekly record of feed, weight and gain. (Ration—Corn, roots and clover hay.)

Dates.	Weight of lambs. Pounds.	Corn. Pounds.	Roots. Pounds.	Hay. Pounds.	Water. Pounds.	Total cost of feed during week.	Total gain per week. Pounds	Cost of one pound of gain.	Average weekly temperature. °F
Nov. 11	752	----------	----------	----------	----------	----------	------	----------	------
" 18	785	59	84	102.5	159	$1.036	33	$0.031	42.3
" 25	812	73	88	108.5	169	1.152	27	.042	31.9
Dec. 2	831	82	91	108.5	184	1.203	19	.063	32.5
" 9	--------	90	91	107	145	1.237	16	.077	24.4
" 16	863	98	91	90	133	1.178	16	.073	25.2
" 23	858	86.5	91	86	163	1.092	-5	--------	51.8
" 30	890	94	91	84	138	1.121	32	.035	40.2
Jan. 6	907	106	91	83.5	106.75	1.182	17	.069	20.7
" 13	937	107	89	74.5	124	1.131	30	.037	28.4
" 20	954	105	91	73.5	134	1.117	17	.065	30.1
" 27	980	111	73	72	145.75	1.117	26	.042	33.5
Feb. 3	1,004	112	70	67.5	151.75	1.092	24	.045	36.1
" 10	1,023	114	70	63	132.25	1.076	19	.056	33.0
" 17	1,076	132	70	52	131.5	1.106	53	.020	26.2
Totals.	--------	1,369.5	1,181	1,172.5	2,017	--------	------	--------	------

FINANCIAL STATEMENT.

Lot 1. (10 Lambs.)

To 10 lambs, 752 lbs. @ 2.37 cts.	$17.82
To feed as follows:	
1,369.5 lbs. shelled corn @ 30 cts. for 56 lbs., or $10.71 per ton	7.34
1,181 lbs. ruta bagas @ $2.50 per ton	1.47
1,172.5 lbs. clover hay @ $12.00 per ton	7.03
Total expenditures	$33.66
By 10 lambs, 1,076 lbs. @ $4.60 per cwt.	$49.50
Profit on each lamb	$1.58

LOT 2. (10 Lambs.)

***Weekly record of feed, weight and gain.* (*Ration—Corn, roots and alfalfa.*)**

Dates.		Weight of lambs. Pounds.	Corn. Pounds.	Roots. Pounds.	Alfalfa. Pounds.	Water. Pounds.	Total cost of feed during week.	Total gain per week. Pounds	Cost of one pound of gain.
November	11	740							
"	18	763	59	84	117.25	186	$1.124	23	$0.048
"	25	776	73	75	126	218	1.240	13	.095
December	2	797	82	91	124	219.5	1.296	21	.061
"	9		83	91	124	182.5	1.302	29.5	.044
"	16	856	98	91	112	172.5	1.310	29.5	.044
"	23	858	84	91	108	180.5	1.211	2	.605
"	30	903	94	91	106	186.5	1.253	45	.027
January	6	923	106	91	96.5	145.5	1.260	20	.063
"	13	948	107	89	77.5	160.25	1.149	25	.045
"	20	978	105	91	74.5	156.25	1.123	30	.037
"	27	992	111	73	72	165.25	1.117	14	.079
February	3	1,016	111	70	54.5	157.25	1.008	24	.042
"	10	1,031	114	70	45.5	137.25	.971	15	.064
"	17	1,084	131	70	45	124.5	1.059	53	.020
Totals			**1,358**	**1,168**	**1,282.75**	**2,381.75**			

FINANCIAL STATEMENT.

Lot 2. (10 Lambs.)

To 10 lambs, 740 lbs. @ 2.37 cts.	$17.53
To feed as follows:	
1,358 lbs. shelled corn, @ 30 cts for 56 lbs., or $10.71 per ton	7.28
1,168 lbs. ruta bagas, @ 2.50 per ton	1.46
1,282.75 lbs. alfalfa, @ $12 per ton	7.69
Total expenditures	$33.96
By 10 lambs, 1,084 lbs. @ $4.60 per cwt.	$49.86
Profit on each lamb	$1.59

LOT 3. (10 Lambs.)

Weekly record of feed, weight and gain. (Ration—Corn, roots, clover hay and millet hay.)

Dates.	Weight of Lambs. Pounds.	Corn. Pounds.	Roots. Pounds.	Clover Hay. Pounds	Millet Hay. Pounds	Water. Pounds.	Total cost of feed during week.	Total gain per week. Pounds	Cost of one pound gain.
Nov. 11	748								
" 18	779	59	84	58	42	134	$0.979	31	$0.031
" 25	795	73	88	56	49.5	162	1.084	16	.067
Dec. 2	808	82	91	56	49	170	1.133	13	.087
" 9		90	91	55	48	137	1.165	24	.048
" 16	856	98	91	46	45.5	131.5	1.141	24	.047
" 23	842	86.5	91	44	37.5	146	1.027	−14	
" 30	882	94	91	42	42	144.75	1.079	40	.026
Jan. 6	902	106	91	41.5	42	117.25	1.140	20	.057
" 13	925	107	89	38.5	36	124.5	1.095	23	.047
" 20	946	105	91	38.5	35	137.25	1.082	21	.051
" 27	965	111	73	37	33	141.5	1.072	19	.056
Feb. 3	995	112	70	33.5	30.5	154.75	1.040	30	.034
" 10	1,021	114	70	31.5	28	144.75	1.027	26	.039
" 17	1,080	132	70	25.5	24	141.5	1.067	59	.018
Totals		**1,369.5**	**1,181**	**603.**	**542.**	**1,986.75**			

FINANCIAL STATEMENT.

Lot 3. (10 Lambs.)

To 10 lambs, 748 lbs. @ 2.37 cts.	$17.72
To feed as follows:	
1,369.5 lbs. shelled corn @ 30 cts. for 56 lbs. or $10.71 per ton	7.34
1,181 lbs. ruta bagas @ $2.50 per ton	1.47
603 lbs. clover hay @ $12.00 per ton	3.62
542 lbs. millet hay @ $10.00 per ton	2.71
Total expenditure	$32.86
By 10 lambs, 1,080 lbs. @ $4.60 per cwt.	$49.68
Profit on each lamb	$1.68

LOT 4. (10 Lambs.)

Weekly record of feed, weight and gain. (Ration—Corn, roots and millet hay.)

Dates.		Weight of lambs. Pounds.	Corn. Pounds.	Roots. Pounds.	Millet hay. Pounds.	Water. Pounds.	Total cost of feed during week.	Total gain per week. Pounds	Cost of one pound of gain.
November	11	729	----	----	----	----	----	----	----
"	18	746	59	84	94.25	116	$0.892	17	$0 052
"	25	770	73	75	107	136.5	1.019	24	.042
December	2	784	82	91	119	172	1.147	14	.081
"	9	----	90	91	102.5	131.5	1.107	8.5	.130
"	16	801	96	91	81.0	144	1.032	8.5	.121
"	23	787	79	91	62.5	169.75	.848	-14	----
"	30	824	93.5	91	56	131.75	.894	37	.024
January	6	847	106	91	63	98.75	.996	23	.043
"	13	875	107	89	49.5	114 25	.931	28	.033
"	20	895	105	91	52.5	143 75	.938	20	.046
"	27	917	111	73	51	135.5	.940	22	.042
February	3	941	112	70	46.5	135.75	.919	24	.038
"	10	971	114	70	42	134.25	.908	30	.030
"	17	987	123	70	32	105.5	.906	16	.056
Totals		----	**1,350.5**	**1,168**	**958.75**	**1,869.25**	----	----	----

FINANCIAL STATEMENT.

Lot 4. (10 Lambs.)

To 10 lambs, 729 lbs. @ 2.37 cts.	$17.27
To feed as follows:	
1,350.5 lbs. shelled corn @ 30 cts. for 56 lbs. or $10.71 per ton	7.23
1,168 lbs. ruta bagas @ $2.50 per ton	1.46
958.75 lbs. millet hay @ $10.00 per ton	4.79
Total expenditures	$30.75
By 10 lambs, 987 lbs. @ $4.60 per cwt.	$45.40
Profit on each lamb	$1.46

LOT 5. (10 Lambs.)

Weekly record of feed, weight and gain. (Ration—Corn, roots, clover hay and oat straw.)

Dates.	Weight of lambs. Pounds.	Corn. Pounds.	Roots. Pounds.	Clover hay. Pounds	Oat straw. Pounds	Water. Pounds.	Total cost of feed during week.	Total gain per week. Pounds	Cost of one pound gain.
Nov. 11	734								
" 18	771	59	84	58	42 5	139	$0.896	37	$0.024
" 25	792	73	75	56	52.5	148	.977	21	.046
Dec. 2	802	76	91	56	52.5	135	1.013	10	.101
" 9		90	91	55.5	52	127.5	1.084	17.5	.061
" 16	837	98	91	46	49	139	1.061	17.5	.060
" 23	832	86.5	91	44.5	49	152.25	.990	-5	
" 30	869	94	91	42	52.5	143.75	1.026	37	.027
Jan. 6	888	106	91	41.5	52.5	107.75	1.087	19	.057
" 13	912	107	89	38.5	45.5	139.25	1.051	24	.043
" 20	927	105	91	38.5	44	134.5	1.039	15	.069
" 27	958	111	73	37	44.5	154	1.040	31	.033
Feb. 3	978	112	70	33.5	41	155.75	1.011	20	.050
" 10	1,003	114	70	31.5	38.5	144.5	1.002	25	.040
" 17	1,051	132	70	25.5	37.5	152	1.059	48	.022
Totals		**1,363.5**	**1,168**	**604.0**	**653.5**	**1,972.25**			

FINANCIAL STATEMENT.

Lot 5. (10 Lambs.)

To 10 lambs, 734 lbs. @ 2.37 cts.	$17.39
To feed as follows:	
1,363.5 lbs. shelled corn @ 30 cts. for 56 lbs. or $10.71 per ton	7.30
1,168 lbs. ruta bagas, @ $2 50 per ton	1.46
604 lbs. clover hay, @ $12 per ton	3.62
653.5 lbs. oat straw, @ $6 per ton	1.96
Total expenditures	$31.73
By 10 lambs, 1,051 lbs., @ $4.60 per cwt.	$48.35
Profit on each lamb	$1.66

LOT 6. (10 Lambs.)

Weekly record of feed, weight and gain. (Ration—Corn, roots and oat straw.)

Dates.	Weight of lambs. Pounds.	Corn. Pounds.	Roots. Pounds.	Oat straw. Pounds.	Water. Pounds.	Total cost of feed during week.	Total gain per week. Pounds	Cost of one pound of gain.
Nov. 11	739							
" 18	766	59	84	93	122	$0.700	27	$0.025
" 25	786	73	75	110	140	.814	20	.040
Dec. 2	792	76	91	122.5	140.5	.887	6	.147
" 9		90	91	120.5	131	.956	15.5	.061
" 16	823	98	91	108.5	125	.963	15.5	.062
" 23	820	86.5	91	106.5	160.5	.895	-3	
" 30	855	94	91	105	154	.932	35	.026
Jan. 6	876	106	91	104.5	113	.994	21	.047
" 13	899	107	91	98	137	.980	23	.042
" 20	912	105	91	96	137.5	.964	13	.074
" 27	937	111	73	89.5	151.5	.953	25	.038
Feb. 3	961	112	70	83	157	.936	24	.039
" 10	985	114	70	80.5	154.5	.939	24	.039
" 17	1,024	132	70	76	141	1.022	39	.026
Totals		1,363.5	1,170	1,393.5	1,964.5			

FINANCIAL STATEMENT.

Lot 6. (10 Lambs.)

To 10 lambs, 739 pounds @ 2.37 cts.	$17.514
To feed as follows:	
1,363.5 lbs. shelled corn @ 30 cts. for 56 lbs. or $10.71 per ton	7.308
1,170 lbs. ruta bagas @ $2.50 per ton	1.462
1,393.5 lbs. oat straw @ $6.00 per ton	4.18
Total expenditures	$30.464
By 10 lambs, 1,024 lbs. @ $4.60 per cwt.	$47.10
Profit on each lamb	$1.66

LOT 7. (10 Lambs.)

Weekly record of feed, weight and gain. (Ration—Corn, roots, clover hay and corn stalks.)

Dates.	Weight of lambs. Pounds.	Corn. Pounds.	Roots. Pounds.	Clover hay. Pounds	Corn stalks. Pounds.	Water. Pounds.	Total cost of feed during week.	Total gain per week. Pounds	Cost of one pound of gain.
Nov. 11	727								
" 18	762	59	84	58	47.25	141	$0.839	35	$0.023
" 25	791	73	75	56	53	178	.899	29	.031
Dec. 2	801	76	91	56	52.5	149	.934	10	.093
" 9		90	91	54.5	49	146	.995	19	.052
" 16	839	98	91	45	52	127.75	.986	19	.051
" 23	831	86.5	91	44	50.5	157.25	.915	-8	
" 30	864	94	91	42	49	135	.942	33	.028
Jan. 6	890	106	91	41.5	49	105.5	1.003	26	.038
" 13	906	107	89	38.5	45.5	117	.983	16	.061
" 20	937	105	91	38.5	45.5	128.25	.975	31	.031
" 27	966	111	73	37	44.5	132	.973	29	.033
Feb. 3	991	112	70	33.5	41	132.75	.949	25	.037
" 10	1,015	114	70	31.5	38.5	135	.944	24	.039
" 17	1,061	132	70	25.5	37.5	127.5	1.003	46	.021
Totals		**1,363.5**	**1,168**	**601.5**	**654.75**	**1,912.0**			

FINANCIAL STATEMENT.

Lot 7. (10 Lambs.)

To 10 lambs, 727 lbs. @ 2.37 cts.	$17.22
To feed as follows:	
1,363.5 lbs. shelled corn, @ 30 cts. for 56 lbs. or $10.71 per ton	7.30
1,168 lbs. ruta bagas, @ $2.50 per ton	1.46
601.5 lbs. clover hay, @ $12 per ton	3.61
654.75 lbs. corn stalks, @ $3 per ton	.98
Total expenditures	$30.57
By 10 lambs, 1,061 lbs., @ $4.60 per cwt.	$48.81
Profit on each lamb	$1.82

LOT 8. (10 Lambs.)

Weekly record of feed, weight and gain. (Ration—Corn, roots and corn stalks.)

Dates.	Weight of lambs. Pounds.	Corn. Pounds.	Roots. Pounds.	Corn stalks. Pounds.	Water. Pounds.	Total cost of feed per week.	Total gain per week. Pounds	Cost of one pound gain.
Nov. 11	753							
" 18	766	59	84	103.5	114	$0.576	13	$0.044
" 25	789	73	75	121.5	147.5	.666	23	.028
Dec. 2	804	76	91	133	132	.719	15	.047
" 9		90	91	111.5	139.5	.762	19.5	.039
" 16	843	98	91	107.5	121	.799	19.5	.040
" 23	835	86.5	91	104.5	157.75	.732	-8	
" 30	871	94	91	105	156.5	.774	36	.021
Jan. 6	887	104	91	103.5	132	.825	16	.051
" 13	911	107	89	92	145.5	.822	24	.034
" 20	937	105	91	87.5	145	.807	26	.031
" 27	962	111	73	86	144.25	.814	25	.032
Feb. 3	987	112	70	83	141	.811	25	.032
" 10	1,009	114	70	80.5	159.75	.819	22	.037
" 17	1,055	133	70	76	154	.913	46	.019
Totals		**1,362.5**	**1,168**	**1,395**	**1,989.75**			

FINANCIAL STATEMENT.

Lot 8. (10 Lambs.)

To 10 lambs, 753 lbs. @ 2.37 cts.	$17.84
To feed as follows:	
1,362.5 lbs. shelled corn @ 30 cts. per 56 lbs. or $10.71 per ton	7.30
1,168 lbs. ruta bagas @ $2.50 per ton	1.46
1,395 lbs. corn stalks @ $3.00 per ton	2.09
Total expenditures	$28.69
By 10 lambs, 1,055 lbs. @ $4.60 per cwt.	$48.53
Profit on each lamb	$1.98

LOT 9. (10 Lambs.)

Weekly record of feed, weight and gain. (Ration—Corn, roots, clover hay and bean straw.

Dates.	Weight of lambs. Pounds.	Corn. Pounds.	Roots. Pounds.	Clover hay. Pounds	Bean straw. Pounds.	Water. Pounds.	Total cost of feed during week.	Total gain per week. Pounds	Cost of one pound gain.
Nov. 11	743	----	----	----	----	----	----	----	----
" 18	772	59	84	58	50	148	$0.944	29	$0.032
" 25	800	73	75	56	57.5	175	1.021	28	.036
Dec. 2	801	70	91	56	56	193	1.020	1	1.020
" 9	----	90	91	55.5	56	187.5	1.124	30.5	.036
" 16	862	98	91	47.5	56	127.75	1.119	30.5	.036
" 23	847	86.5	91	44	52	150.25	1.022	-15	----
" 30	883	94	91	42	49	129.5	1.040	36	.028
Jan. 6	909	106	91	41.5	49	117.5	1.101	26	.042
" 13	922	107	89	38.5	43	110.25	1.065	13	.081
" 20	953	105	91	38.5	42	127.5	1.054	31	.034
" 27	978	111	73	37	42	128.5	1.054	25	.042
Feb. 3	1,000	112	70	33.5	41	141.75	1.031	22	.046
" 10	1,021	114	70	31.5	38.5	144	1.022	21	.048
" 17	1,066	133	70	25.5	37.5	135.5	1.083	45	.024
Totals	----	**1,358.5**	**1,168**	**605**	**669.5**	**2,016**	----	----	----

FINANCIAL STATEMENT.

Lot 9. (10 Lambs.)

To 10 lambs, 743 lbs., @ 2 37 cts.	$17.60
To feed as follows:	
1,358.5 lbs. shelled corn, @ 30 cts. for 56 lbs., or $10.71 per ton	7.28
1,168 lbs. ruta bagas, @ $2.50 per ton	1.46
605 lbs. clover hay, @ $12 per ton	3.63
669.5 lbs. bean straw, @ $7 per ton	2.34
Total expenditures	$32 31
By 10 lambs, 1,066 lbs., @ $4.60 per cwt.	$49.03
Profit on each lamb	$1.67

LOT 10. (10 Lambs.)

Weekly record of feed, weight and gain. (Ration—Corn, roots and bean straw.)

Dates.		Weight of lambs. Pounds.	Corn. Pounds.	Roots. Pounds.	Bean straw. Pounds.	Water. Pounds.	Total cost of feed during week.	Total gain per week. Pounds	Cost of one pound of gain.
Nov.	11	745	--------	--------	--------	--------	--------	------	--------
"	18	757	59	84	112.5	174	$0.815	12	$0.067
"	25	773	73	75	125	184	.921	16	.057
Dec.	2	791	82	91	119	183.5	.968	18	.053
"	9	--------	90	91	112	169.25	.987	25	.039
"	16	841	98	91	118	141.5	1.051	25	.042
"	23	841	86.5	91	111.5	164.75	.966	-0	--------
"	30	874	94	91	112	156.5	1.009	33	.030
Jan.	6	892	106	91	111.5	126	1.071	18	.059
"	13	907	107	89	96	140.5	1.020	15	.068
"	20	929	105	91	94.5	136.5	1.007	22	.045
"	27	957	111	73	88.5	163.25	.995	28	.035
Feb.	3	987	112	70	83	168.75	.977	30	.032
"	10	998	114	70	80.5	159.25	.980	11	.089
"	17	1,041	133	70	79	160	1.075	43	.025
Totals		--------	**1,370.5**	**1,168**	**1,448.0**	**2,227.75**	--------	------	--------

FINANCIAL STATEMENT.

Lot 10. (10 Lambs.)

To 10 lambs, 745 lbs, @ 2.37 cts.	$17.65
To feed as follows:	
1,370.5 lbs, shelled corn @ 30 cts. for 56 lbs. or $10.71 per ton	7.34
1,168 lbs. ruta bagas @ $2 50 per ton	1.46
1,443 lbs bean straw @ $7.00 per ton	5.05
Total expenditures	$31.50
By 10 lambs, 1,041 lbs. @ $4.60 per cwt.	$47.88
Profit on each lamb	$1.63

TABLE I.—*Financial Summary.—Length of feeding period 14 weeks.*

Lot.	Distinguishing rations.	Average weight of lambs at the beginning of the feeding period.	Average weight of lambs at the end of the feeding period.	Cost of one pound gain.	Average total gain for each lamb for period.	Average cost of each lamb at beginning of the feeding period.	Average cost of feed for each lamb during the period.	Average price received for each lamb at the end of feeding period.	Average profit on each lamb for whole period.
1	Corn, roots and clover hay	75.2	107.6	$0.488	32.4	$1.782	$1.584	$4.949	$1.583
2	Corn, roots and alfalfa	74.0	108.4	0.477	34.4	1.753	1.642	4.986	1.590
3	Corn, roots, clover hay and millet hay	74.8	108.0	0.456	33.2	1.772	1.513	4.968	1.682
4	Corn, roots and millet hay	72.9	98.7	0.522	*25.8	1.727	1.347	4.540	1.464
5	Corn, roots, clover hay and oat straw	73.4	105.1	0.452	31.7	1.789	1.433	4.884	1.661
6	Corn, roots and oat straw	73.9	102.4	0.453	28.5	1.751	1.293	4.710	1.665
7	Corn, roots, clover hay and corn stalks	72.7	106.1	0.399	33.4	1.722	1.334	4.880	1.823
8	Corn, roots and corn stalks	75.3	105.5	0.358	30.2	1.789	1.083	4.853	1.984
9	Corn, roots, clover hay and bean straw	74.3	106.6	0.455	32.3	1.760	1.470	4.903	1.672
10	Corn, roots and bean straw	74.5	104.1	0.467	29.6	1.765	1.384	4.788	1.638

* This lot was troubled from time to time, especially during the early part of the feeding period with scours.

One of the important things for a sheep feeder to know is about how much it costs to grow or produce a pound of mutton. It is doubtful whether the average prices of food stuffs will rule higher during any one season than those current last winter, consequently where proper care is taken in feeding, the cost of a pound of gain should not exceed five cents.

The uniformity in weight of the lambs at the beginning of the experiment was of course a result of the careful assorting and other than to show that fact, the first column of figures is of no importance. On the other hand the great similarity in weight of the lambs at the end of the fattening period is very suggestive, fed as they were on such a variety of rations it clearly emphasizes the great importance of skill in feeding as well as the kind of food consumed in obtaining good results. This is still further shown by the average cost of feed for each lamb, average net profit on each lamb, total gain per lamb and cost of a pound of gain.

Perhaps the most significant fact exhibited by this table is that under the conditions obtaining in this experiment every lot with the exception of lot 4, fed millet hay, gave a greater average net profit than did the lot receiving clover hay alone as the fodder ration. The lot showing the highest average net profit was lot 8, fed corn stalks alone as the fodder ration, while lot 4 receiving millet hay gave the smallest net profit per lamb.

It is also of interest to note the similarity in the average gain of the lambs in lots 1, 2, 3, 5, 7, 8 and 9. The increased profit in case of corn stalks and some other fodders was not due therefore to greater gains but to smaller cost of food stuffs. While perhaps one ration may produce a pound of gain as economically as others it may yet be an inferior ration for fattening lambs because it fails to produce *large* gains. Any condition which would cause a change in price of food stuffs would greatly alter the results exhibited in this table.

TABLE II.—*Average weekly gain per lamb and average weekly temperature.*

Dates.	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	Lot 7	Lot 8	Lot 9	Lot 10	Average weekly gain.	Average weekly temperature.
Nov. 11	----	----	----	----	----	----	----	----	----	----	----	----
" 18	3.3	2.3	3.1	1.7	3.7	2.7	3 5	1.3	2.9	1.2	2 57	42 3
" 25	2.7	1.3	1.6	2.4	2.1	2.0	2.9	2.3	2.8	1.6	2.17	31.9
Dec. 2	1.9	2.1	1.3	1.4	1.0	.6	1.0	1.5	.1	1.8	1.27	32.5
" 9	----	----	----	----	----	----	----	----	----	----	----	24.4
" 16	*3.2	5.9	4.8	1.7	3.5	3.1	3.8	3.9	6.1	5.0	4.01	25.2
" 23	-.5	.2	-1.4	-1.4	-.5	-.3	-.8	-.8	-1.5	0.0	-.70	51.8
" 30	3.2	4.5	4.0	3.7	3.7	3.5	3.3	3.6	3.6	3.3	3.64	40.2
Jan. 6	1.7	2.0	2.0	2.3	1.9	2.1	2.6	1.6	2.6	1.8	2.06	20.7
" 13	3.0	2.5	2 3	2.8	2.4	2.3	1.6	2.4	1.3	1.5	2.21	28.4
" 20	1.7	3.0	2.1	2.0	1.5	1.3	3.1	2.6	3.1	2 2	2.26	30.1
" 27	2.6	1.4	1.9	2.2	3.1	2.5	2.9	2.5	2.5	2.8	2.44	33.5
Feb. 3	2.4	2.4	3.0	2.4	2 0	2.4	2.5	2.5	2.2	3.0	2.48	36.1
" 10	1.9	1.5	2 6	3.0	2.5	2.4	2.4	2 2	2.1	1.1	2.17	33.0
" 17	5.3	5.3	5.9	1.6	4.8	3.9	4.6	4.6	4.5	4.3	4.48	26.2
Av. w'k'y gain	2.31	2.45	2.37	1.84	2.26	2.03	2.38	2.15	2.30	2.11	----	----

* Gain for two weeks.

The above table shows, the average gain per lamb by weeks for each lot, and both the average gain per lamb in each pen and the average gain by weeks throughout the whole period for all the lots, also the average weekly temperature. December 6 the lambs were dipped and owing to the unfavorable weather were still damp on Monday morning the 9th, which was the regular time for weighing, consequently it was thought best not to weigh until December 16, the gains recorded opposite that

date are therefore for two weeks. The gains were quite uniform from week to week except in case of the week ending December 23, when there was a decided loss in all but two pens.

TABLE III.—*Summary of food consumed and dry matter.*

Lots.	Distinguishing rations.	Amount of corn fed during period.	Amount of roots fed during period.	Amount of fodder fed during period.	Amount of water drunk. Pounds.	Total amount of dry matter consumed. Pounds.	Pounds of dry matter to a pound of gain.
1	Corn, roots and clover hay	1,369.5	1,181	1,147.5	2,017	2,327.07	7.182
2	Corn, roots and alfalfa	1,358	1,168	1,228	2,381.75	2,462.18	7.157
3	Corn, roots, clover hay and millet hay	1,369.5	1,181	*600 †540.75	1,986.75	2,362.56	7.116
4	Corn, roots and millet hay	1,350.5	1,168	916	1,869.25	2,181.96	8.457
5	Corn, roots, clover hay oat straw	1,363.5	1,168	*602 ‡581.5	1,972 25	2,340.40	7.882
6	Corn, roots and oat straw	1,363.5	1,170	1,129.75	1,964.25	2,374.28	8.330
7	Corn, roots, clover hay and corn stalks	1,363.5	1,168	*586.5 ‖562.75	1,912	2,181.88	6.532
8	Corn, roots and corn stalks	1,362.5	1,168	1,159	1,989.75	2,041.36	6.758
9	Corn, roots, clover hay and bean straw	1,358.5	1,168	*603 §602.5	2,016	2,386.93	7.352
10	Corn, roots and bean straw	1,370.5	1,168	1,309.2	2,227.75	2,501.63	8.472

* Clover hay.
† Millet hay.
‡ Oat straw.
‖ Corn stalks.
§ Bean straw.

The amount of corn and roots fed to the various lots was practically the same though each lot was fed what they, in the judgment of the feeder, required. Where clover hay was fed with some other fodder it was fed at night and the other fodder in the morning. The total amount of clover hay fed in this way to lots 3, 5, 7 and 9 was within a very few pounds the same. Knowing these facts, comparisons between the different fodders become all the more valuable as no one can attribute the good results obtained to the increased amount of grain or roots fed to any particular lot.

Speaking in general terms the lambs drank an average of about two pounds of water each per day. The column showing the total amount of dry matter eaten indicates the amount eaten as stated and not the amount fed as in some cases there was quite a little waste, especially with such fodders as corn stalks and oat straw. The results tabulated in the last column of the above table are important not only from a scientific but a practical standpoint. These figures give the number of pounds of dry matter required to produce a pound of gain. This datum is important for, while the net profit on lambs in the different lots depends upon the current prices of food stuffs, the dry matter required to produce a pound of gain would remain substantially the same from year to year. Only 6.76 pounds of dry matter were required to produce a pound of gain when corn stalks were used as fodder. This was the best showing made by any fodder used in the experiment. On the other hand fully a pound and one-half more of dry matter was necessary to produce a pound of gain in those lots which were fed millet hay and oat straw. In the remaining lots there was but little variation in this particular.

TABLE IV.—*Total protein, carbohydrates and fat.*

Lot.	Distinguishing rations.	Average weekly gain of each lamb.	Pounds of fodder fed to one pound gain.	Pounds of grain fed to one pound of gain.	Digestible protein fed per day per 1,000 pounds.	Digestible Carbohydrates fed per day per 1,000 pounds.	Digestible fat.	Nutritive ratio.
1	Corn, roots and clover hay	2.81	3.54	4.227	2.03	14.99	.87	1: 8.4
2	Corn, roots and alfalfa	2.45	3.55	3.947	2.23	15.61	.84	1: 7.9
3	Corn, roots, clover hay and millet hay	2.37	3.43	4.125	1.91	15.66	.88	1: 9.3
4	Corn, roots and millet hay	1.84	3.55	5.234	1.75	16.11	.81	1:10.4
5	Corn, roots, clover hay and oat straw	2.26	3.57	4.301	1.78	15.63	.83	1: 9.9
6	Corn, roots and oat straw	2.03	3.96	4.784	1.45	16.27	.78	1:12.6
7	Corn, roots, clover hay and corn stalks	2.38	3.44	4.082	1.78	15.18	.82	1: 9.7
8	Corn, roots and corn stalks	2.15	3.83	4.511	1.47	14.94	.75	1:11.4
9	Corn, roots, clover hay and bean straw	2.30	3.73	4.205	-------	--------	-----	--------
10	Corn, roots and bean straw	2.11	4.42	4.630	-------	--------	-----	--------

It is remarkable that the amount of fodder and grain fed to produce a pound of gain was so uniform in all the lots. In Table III it is shown that the total amount of corn and roots fed to each lot was practically the same, so that we are safe in concluding that the differences in results were due to the fodders in the ration rather than to the differences in the amount of grain fed. It might be thought that the variations would have been more marked had the proportion of fodder to grain been greater but there was not an excessive amount of grain fed as compared with the fodder, the relation existing between the two being practically what the appetites of the lambs demanded and the same as it has been in previous years.

TABLE V.—*Individual weights aud gains of lambs.*

	Lot 1.										Lot 2.									
Ear tag of lambs	321	407	417	423	432	429	449	450	492	662	304	314	316	317	421	438	483	470	476	488
Weight at beginning of period	84	67	84	84	84	61	62	71	82	73	75	74	76	69	82	80	62	83	68	71
Weight at end of period	120	96	118	113	115	86	90	101	113	124	112	102	124	100	120	116	92	116	104	98
Total gain of each lamb	36	29	34	29	31	25	28	30	31	51	37	28	48	31	38	36	30	33	36	27
	Lot 3.										Lot 4.									
Ear tag of lambs	306	327	415	420	439	461	465	473	487	491	303	307	409	410	312	331	324	478	493	495
Weight at beginning of period	73	95	81	61	79	64	79	70	82	64	78	77	69	73	72	76	73	57	74	80
Weight at end of period	111	136	121	85	113	88	105	102	121	98	102	89	87	114	92	113	98	76	102	114
Total gain of each lamb	38	41	40	24	34	24	26	32	39	34	24	12	18	41	20	37	25	19	28	34
	Lot 5.										Lot 6.									
Ear tag of lambs	310	328	411	414	418	426	427	463	475	482	319	320	330	413	430	433	412	437	467	484
Weight at beginning of period	77	65	90	68	82	78	68	58	70	78	70	66	75	72	81	79	77	80	60	79
Weight at end of period	114	91	129	107	104	106	106	83	95	116	96	97	90	110	115	110	114	105	85	102
Total gain of each lamb	37	26	39	39	22	28	38	25	25	38	26	31	15	38	34	31	37	25	25	23

	Lot 7.										Lot 8.									
Ear tag of lambs	318	322	323	329	451	469	474	481	486	485	309	313	315	406	422	448	419	468	496	408
Weight at beginning of period	78	83	77	79	58	55	70	79	66	82	68	69	100	72	84	59	82	81	73	65
Weight at end of period	108	107	112	96	100	93	102	110	108	125	139	105	104	87	112	95	112	108	108	85
Total gain of each lamb	30	24	35	17	42	38	32	31	42	43	71	36	4	15	28	36	30	27	35	20
	Lot 9.										Lot 10.									
Ear tag of lambs	311	325	332	416	425	434	436	458	460	479	424	431	435	447	457	464	477	480	678	494
Weight at beginning of period	67	80	65	89	90	73	76	51	76	76	77	90	76	64	70	68	85	65	73	77
Weight at end of period	108	107	94	121	120	100	118	76	116	106	102	126	110	93	100	98	122	80	110	100
Total gain of each lamb	41	27	29	32	30	27	42	25	40	30	25	36	34	29	30	30	37	15	37	23

The above table shows the weight of each lamb in each lot at the beginning and at the end of the experiment and is given to exhibit the variation in gains made by different lambs on the same feed. It emphasizes the great importance to be attached to having lambs in different lots of equal thrift. Also that the different lots should contain as many lambs as possible to partially do away with the chances for error in results due to individual differences in lambs.

TABLE VI.—*Waste of different fodders in pounds during whole period.*

Lot	1	2	3	4	5	6	7	8	9	10
Clover hay	27	----	8	----	2	----	15	----	2	----
Alfalfa	----	59.75	----	----	----	----	----	----	----	----
Millet hay	----	----	4	42.75	----	----	----	----	----	----
Oat straw	----	----	----	----	132	244	----	----	----	----
Corn stalks	----	----	----	----	----	----	92	215	----	----
Bean straw	----	----	----	----	----	----	----	----	67	133.75

FEEDING CORN SMUT TO DAIRY COWS.

BY CLINTON D. SMITH.

Prof. C. F. Wheeler, the botanist of the station, reports as follows concerning the life history of corn smut and precautions to be observed to avoid its farther extension:

"*Life History.*—In an address delivered before the Agricultural Club at Berlin, Germany, February 11, 1888, Dr. Oscar Brefeld first gave to the world the true life history of corn smut. For twelve years he had experimented with the greatest care, both in the field and in the laboratory, to learn the actual behavior of the smuts of cereals.

It had been proven before this time that the smuts of wheat, barley and oats enter the sprouting grain when the young stem is less than one-quarter of an inch in length and grow upwards with the growth of the stem until the grains in the head are formed, when they at once seize upon this storehouse of prepared food, appropriating it to their own use. Until 1887 it was supposed that corn smut followed the same course of development.

The crowning glory of Brefeld's discovery is in proving that corn smut may infect the plants at any time before their full maturity, and moreover that the ripened smut spores themselves do not directly, by falling upon the corn plants, produce the disease.

The black dusty masses of ripened smut boils contain multitudes of dark brown spores well protected with thick walls, making them capable of resisting extremes of temperature and moisture and retaining their germinating power for a number of years.

These spores were found by Brefeld to germinate readily outside and away from corn plants whenever placed in moist fresh manure. He also found that they would not germinate readily in pure water, but that in manure water the spores germinate rapidly, forming a multitude of short branches which produced secondary spores in great numbers. These secondary spores are formed in the air, on the surface of water, also beneath it, and are easily carried by winds to fields, falling upon all parts of corn plants. Dew and rain carry these small spores inside the leaf sheaths and the husks of the ears, where they at once send out germ tubes that enter the plants, producing a local disease (the well

known smut boils) near the place of infection. In two or three weeks after the infection the characteristic smut boils appear.

This disease has been known since the discovery of America and has followed the introduction of corn raising into all parts of the globe.

The loss to the corn crop is rarely a serious one, in ordinary years, not averaging over two per cent.

Prevention.—No remedy for corn smut is known. From the above account of its life history it is evident that it is useless to treat the seed previous to planting. No doubt fungicides sprayed upon the growing corn might check the disease, but this treatment is not practicable.

Certain precautions may lessen the disease, for instance, cutting out and destroying smutted parts before the spores ripen and the use of chemical fertilizers and well rotted manure with a reasonable rotation of crops. The use of manure from stock fed with silage of smutted corn certainly tends to increase the liability to infection in fields to which such manure is applied. Our knowledge of the manner in which the disease is carried from field to field is wanting."

The Feeding Experiment.

The unusual prevalence of smut in the College corn fields in the fall of 1895 furnished the material for an experiment to test the effect of feeding corn smut both in moderate and excessive quantities to dairy cows.

The smut was gathered after the corn was cut and no attempt was made to entirely separate the husks and small abortive ears from the actual smut boils. Many masses of smut fell to the ground and brought away with them small quantities of sand. The figures given in the tables below, therefore, indicate not the exact amount of smut consumed, since with the smut there was a small but uncertain per cent of sand, husks and small pieces of leaves and abortive ears. The smut was drawn to the barn as fast as gathered and stored in bulk. It suffered no apparent fermentation or change of any kind before it was fed.

The smut was given to the cows mixed with their grain ration, which consisted of corn, four parts; wheat bran, three parts; ground oats, two parts, and oil meal, one part.

The rough feed consisted of corn stalks cut into inch lengths and a small ration of hay, never exceeding six pounds per day, thus compelling the cows to derive the principal part of their nourishment from the corn stalks and the smut and grain ration.

The four cows used in the experiment were grades, apparently vigorous and healthy, purchased in the vicinity of the College. The essential facts in regard to them are as follows:

TABLE I.

Name.	Breed.	Age, years.	Due to calve.
Materna	Shorthorn	9	Feb. 5, 1896.
Milla	"	7	Dec. 5, 1895.
Hebe	"	5?	Feb. 15, 1896.
Halo	Jersey	7	Aug. 1, 1896.

The experiment began November 6, 1895.

Materna and Milla, the former six months in calf at the beginning of the experiment and the latter due to calve early in its progress, were fed corn smut in as large doses as they could be induced to receive it.

Halo fresh in milk, and Hebe six months in calf at the beginning of the experiment received the smut in moderate doses only.

To each of the two cows, Hebe and Halo, two ounces of smut were given daily from the 7th to the 12th of November. On the 12th this quantity was doubled, each cow receiving four ounces. On the 13th the ration of smut was again doubled and each cow was given one-half pound. This quantity was again increased on the 15th to twelve ounces and finally on the 17th to one pound per day.

A pound of smut in the condition existing at the time of the experiment would fill a two-quart measure.

For Materna and Milla on the other hand the dose was very rapidly increased from two ounces per day, on the 7th and 8th of November, to four ounces on the 9th and 10th, six ounces on the 11th and 12th, twelve ounces on the 13th and 14th, one pound and a quarter on the 15th and 16th, one pound and three-fourths on the 17th and 18th and finally two pounds per day of the smut each, from the 19th of November to the 12th of December inclusive. In order to test the matter fully the amount given these cows was very rapidly increased after the 13th of December. On that day they each received three pounds of smut, on the 14th four pounds, on the 15th five pounds, on the 16th six pounds, on the 17th seven pounds, on the 18th ten pounds, and finally on the 19th eleven pounds, when the experiment closed.

Ten pounds of smut shovelled into a half bushel measure filled it. It is evident that the cows received in this daily ration more smut than they could possibly get in foraging over a corn field after the removal of the crop or in the stables in the winter when fed exclusively upon corn stalks as the roughage of the ration.

At the beginning of the experiment the cows ate the smut with great avidity, and the two cows, Hebe and Halo, who received it in moderate quantities only, continued to prefer it to their grain feed up to the close of the experiment. The two cows who received it in immoderately large quantities, on the other hand, manifested a less liking for it, as the quantity was increased, although they did not reject it up to the very last day of the experiment.

No change in appearance was noticed in the dung until the 22d of November, when it was observed to be distinctly darker than that of other cows in the stable fed a similar ration of grain and fodder without the smut. In consistency it was somewhat harder than normal and possibly in the cases of Materna and Milla, somewhat scantier.

Except in the case of Milla, who dropped her calf on the 5th of December, the weights of the cows for the most part gradually increased. Certainly no ill effect was noticed which could be ascribed to the feeding of corn smut.

An examination of Table III reveals no variations in temperature that could be ascribed to the corn smut. The low temperature of Materna on November 8 was due to her having been exposed to a cold rain storm for a couple of hours previous to the taking of the temperature. The temperature of Milla dropped suddenly just prior to her calving.

The following table gives the weights of the cows by weeks beginning with the 12th of November and ending with Christmas.

TABLE II.—*Weights of the cows by weeks.*

Date.	Materna.	Milla.	Hebe.	Halo.
	lbs.	lbs.	lbs.	lbs
November 5	930	1,046	922	754
" 12	994	1,074	992	742
" 19	960	1,088	960	744
" 26	1,007	1,088	991	796
December 3	990	1,114	1,004	785
" 10	1,000	975	1,018	768
" 17	1,072	912	1,022	778
" 24	1,007	875	1,016	787

The temperature of each cow was taken at the same hour three times per week. In the following table these temperatures are arranged in order.

TABLE III.—*Temperatures of the four cows on alternate days.*

Date.	Halo.	Hebe.	Materna	Milla.
November 6	101.4	102.4	103.	102.4
" 8	101.3	101.4	98.	102.6
" 9	101.	100.8	101.4	102.8
" 11	101.7	101.8	102.	103.2
" 13	......	101.8	102.1	103.5
" 15	101.2	101.1	101.4	102.4
" 18	101.	101.5	101.	102.1
" 20	101.8	102.	102.	103.4
" 22	101.2	103.1	101.8	103.
" 25	101.6	102.8	103.4	103.4
" 27	101.8	102.	103.2	103.4
" 29	101.7	101.9	103.9	103.4
December 2	101.5	103.2	103.4	103.9
" 4	102.	102.5	102.	101.9
" 6	103.8	102.4	102.5	101.8
" 10	101.6	102.	103.	102.
" 12	102.	102.	103.4	102.
" 14	103.1	101.9	102.8	101.5
" 16	101.4	101.8	102.5	101.5
" 19	101.6	101.8	103.1	103.
" 21	101.3	100.6	102.	102.7
" 23	101.6	101.4	101.4	101.4
" 26	101.4	103.3	103.8	101.4

The pregnant cows were watched for signs of abortion, but none appeared.

Their milk yield was regular and constant, in the case of the cows giving milk, and no indication was given of any variation in this respect from normal conditions.

On the very last day of the experiment, five pounds of the corn smut were given in the morning and six pounds at night to Materna and Milla.

The following morning it was found that the night feed had not been entirely eaten up, approximately three-fourths of a pound of the mixed grain and smut being left in each manger. Their appetite for smut seemed to have been completely satisfied for the first time during the experiment.

On December 20, four pounds of smut were again fed these cows, mixed as usual with their grain feed. While the cows did not absolutely refuse the mixture, they ate it with very evident reluctance. The bowels of Milla were loose from the heavy feeding of the day previous and the cow seemed decidedly indisposed. Her temperature rose to 103° on the evening of December 19, the day on which she received the eleven pounds of smut.

The behavior of the two cows, Materna and Milla, was watched for a week thereafter. They continued in good health and gave no signs of any abnormal condition of the bowels. Their dung gradually lost the dark color and the cows then became in every way normal.

Samples of the corn smut were placed in the hands of the chemist for analysis, with the following results:

Composition of Corn Smut.

Moisture	8.30 per cent.
Albuminoids	13.06 " "
Carbohydrates	25.60 " "
Cellulose	24.69 " "
Sugar	4.00 " "
Fat	1.35 " "
Ash—much sand	22.50 " "

Dr. R. C. Kedzie, the chemist of the station, in commenting on this analysis, says "that the ash was rich in the phosphates of potash and magnesium like the ash of grain, but a large part of the ash was sand accidently present from contact of the smut with the ground while gathering."

"The smut was carefully examined for poisonous alkaloids to see whether the alleged poisonous properties of the smut could be explained by the presence of any organic poison, but not a trace could be detected, although a large quantity (twenty grams) was used for this purpose.

"It is surprising to see the avidity with which cattle will eat the corn smut and it seems difficult to explain their appetite for so repulsive a material. Perhaps the presence of sugar (four per cent) in the smut may explain this, for the reason that cattle are very fond of sugar."

The conclusion which can be safely drawn from this experiment is, that where cows are gradually brought into the habit of consuming large quantities of smut it does not seem hurtful to them. Whether the same thing would be true where cows unaccustomed to smut suddenly gain access to large quantities of it must remain for future experiment. It is safe to say, however, that any quantity of smut that would be at all likely to exist in a cornfield or on the stalks as fed under normal conditions to the cows of the farmer, would not be dangerous to the health of the animals.

In 1868, Prof. John Gamgee, in investigating the "corn stalk disease," fed experimentally forty pounds of corn smut to two cows, beginning

with six and increasing to twelve ounces daily. The smut was fed with ground grain and chopped hay. To one cow it was given wet, to the other dry. The cow that received the wet ration gained in weight during the trial, the other lost in weight, but both remained well.

Dr. N. S. Mayo, in discussing the relation of corn smut to "the corn stalk disease of cattle," in Bulletin No. 58 of the Kansas Experiment Station, records the experience of a farmer living near Manhattan who, believing that corn smut was liable to produce the disease, took pains to gather the smut from the field. "One night his cattle broke into the enclosure where the smutty corn and smut had been thrown out and ate all they wished; no injurious effects were noticed."

In Bulletin No. 10, U. S. Department of Agriculture, Bureau of Animal Industry, there is recorded the results of an experiment performed in January, 1894, of feeding corn smut in large quantities to two heifers. The results are reported as follows:

"Beginning on the morning of January 17, 1894, and continuing until noon of February 2 (sixteen and one-half days), the heifers were fed morning and evening with from two to three quarts of a mixture of equal parts by weight of cut hay and a mixture of corn meal, middlings and wheat bran, and sixteen quarts of smut. The actual quantity of the fungus consumed by one heifer was sixty-one pounds or a daily average of nearly three and seven-tenths pounds, and by the others sixty-seven and one-half pounds, or a daily average of four and one-fifth pounds. The temperatures of the animals were taken every morning and evening. The animals appeared to be perfectly well throughout the time of feeding and continued so for several months, during which time they were kept under close observation."

The results of our experiment coincide with those of other experiments whose records are available and may be taken as showing that no danger is to be apprehended from the feeding of smutty stalks, either to pregnant dairy cows or to those in full milk. It is unquestionably true that the feeding of smutty stalks and corn perpetuates the disease from year to year through the medium of the manure. It is otherwise good management to haul manure directly from the stable to the fields, usually in sod, on which the corn is to be planted the following year, although such a course, while economizing the human labor in the care of the cows, brings about the best possible conditions for infecting the corn crop. No statistics are at hand to show that the corn smut is more prevalent in recent years than heretofore, although the practice of hauling out manure as fast as it is made has been common for many years.

To prevent the spread of the disease it may be expedient to remove the growing smut boils before the spores mature, but the expense of going through the corn field as often as would be necessary to accomplish this purpose would be so great as to render the method out of the question for the ordinary farmer. After the dark brown masses of spores have become ripe and dry, but little advantage can result from cutting them off and leaving then in the corn field where they would be blown about by the winds.

PIG FEEDING.

BY CLINTON D. SMITH.

I. Gains Before and After Weaning.

The object of this feeding experiment was to afford additional data in answer to the question whether the gains made by young pigs before weaning were put on at a greater or less cost per pound than when the pigs were older.

The sows and pigs before weaning and the pigs thereafter were fed on a ration of skim milk and a grain mixture of one part corn meal and two parts middlings. The supply of skim milk varied from week to week and no constant relation between the quantity of grain ration and of skim milk was maintained.

The pigs were encouraged to eat in the trough with their dams as early as possible. When, therefore, they came to weaning, they were already in the habit of eating from a trough and the change from the milk of the dam to the new ration was neither sudden nor extreme.

Two sows and litters were used in the test.

One of them was a registered Duroc Jersey, four years old, and with her fourth litter. She had by her side at the beginning of the experiment eight pigs apparently even in growth, sound and thrifty. They were farrowed March 20.

The other sow was a registered Poland China with nine pigs, her second litter. These pigs were farrowed April 6. The pigs in both litters were marked and numbered by ear tags. Their weights were taken weekly from the 13th of April, when the experiment began, until the 10th of August. These weights are recorded in the following table to illustrate the variations in growth between individual pigs from week to week.

These weekly weights are combined in Table II and the weights of the sows while running with the pigs are also given.

TABLE I.—*Weights of pigs.*

Date.	Duroc Jersey Pigs.								Poland China Pigs.								
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	9
April 13	12.5	13.25	10.5	12.5	8.75	13.	7.75	12.25	3.75	3.63	3.38	5.25	4.5	4.5	5.	3.	5.5
" 20	17.25	18.5	15.75	16.5	12.25	17.75	10.5	17.5	6.25	6.25	8.75	7.75	7.5	6.25	8.25	4.75	7.75
" 27	22.25	21.75	19.25	20.5	18.	22.25	14.25	22.	7.25	7.5	10.	9.25	9.	7.5	10.5	6.5	9.
May 4	29.25	28.	25.12	27.25	17.25	29.75	18.25	28.	10.75	10.25	13.	13.	12.	10.	14.5	9.25	12.25
" 11	36.5	35.	31.	35.	24.5	36.75	23.25	34.5	14.5	13.5	16.5	17.	17.5	15.	19.5	14.	17.
" 18	42.	39.5	34.	41.5	29.	42.25	29.5	39.5	19.75	17.5	20.5	23.	23.	19.25	25.	18.5	21.75
" 25	48.5	50.	45.5	50.5	35.	49.	36.5	50.	25.5	20.5	26.5	26.	27.	25.	31.5	23.5	28.
June 1	55.5	55.5	49.	59.	40.	59.5	45.5	56.	29.5	27.	30.	33.	30.5	31.	38.5	28.5	33.
" 8	64.5	60.5	56.5	62.	49.	61.5	48.5	58.5	33.	30.	34.5	37.5	33.5	34.5	41.5	33.5	36.5
" 15	68.	63.	62.	67.5	50.5	53.5	52.	66.5	38.	37.	40.	43.5	41.5	40.	48.	39.	41.
" 22	83.	78.	72.	78.	56.5	74.5	63.	74.	44.5	42.5	49.	53.5	49.	45.	57.	46.5	47.5
" 29	88.	81.	78.	88.5	66.	79.	61.	79.	47.	51.	53.	56.	51.	53.	63.	52.	53.
July 6	100.	76.	85.	93.	69.	85.	75.	83.	56.	54.	55.	59.	58.	58.	71.	59.	61.
" 13	104.	90.	83.	94.	78.	86.	75.	88.5	59.	57.	59.	64.	58.	65.5	72.	60.	63.5
" 20	114.	98.5	100.	104.	88.	100.	88.	93.5	63.5	64.5	67.	70.5	68.	69.	78.	73.	69.
" 27	123.	105.	105.5	112.	91.	99.	86.	103.	68.5	68.5	71.5	79.	73.5	75.5	84.5	77.	76.5
Aug. 3	130.5	111.	111.5	117.	92.5	108.	98.5	107.5	74.5	76.5	89.5	85.	75.	80.5	82.	84.	91.
" 10	137.5	111.5	118.5	117.	101.	123.5	102.	116.	83.	81.5	86.5	91.5	82.5	88.5	95.	90.5	91.5
Total gain	125.0	98.25	108.0	104.5	92.25	110.5	94.25	103.75	79.25	77.87	83.12	86.25	78.0	84.0	90.0	87.5	86.0
Weekly gain	7.35	5.77	6.35	6.14	5.43	6.5	5.54	6.10	4.66	4.58	4.89	5.07	4.58	4.94	5.30	5.14	5.06

TABLE II.—*Weights of sows and litters.*

Date.	Duroc Jersey. Weight of sow. Lbs.	Duroc Jersey. Weight of pigs. Lbs.	Duroc Jersey. Gain of pigs. Lbs.	Poland China. Weight of sow. Lbs.	Poland China. Weight of pigs. Lbs.	Poland China. Gain of pigs. Lbs.
April 13	420.	90.5	....	294.5	41.25	....
" 20	448.5	126.0	35.5	311.0	63.5	22.25
" 27	436.0	155.5	29.5	311.5	76.5	13.0
May 4	454.0	202.9	47.4	299.0	105.0	28.5
" 11	437.0	258.5	55.6	285.0	144.5	39.5
" 18	423.0	297.25	38.75	286.5	186.25	41.75
" 25	....	365.0	67.75	299.0	233.5	47.25
June 1	....	420.0	55.0	....	279.0	45.5
" 8	....	458.0	38.0	....	319.5	40.5
" 15	....	493.0	35.0	....	368.0	48.5
" 22	....	575.0	82.0	....	435.5	67.5
" 29	....	633.5	58.5	....	478.0	42.5
July 6	....	676.0	42.5	....	527.0	49.0
" 13	....	709.0	33.0	....	558.0	31.0
" 20	....	781.0	72.0	....	622.5	64.5
" 27	....	823.5	42.5	....	674.5	52.0
August 3	....	871.5	48.0	....	728.0	53.5
" 10	....	927.0	55.5	....	789.5	61.5
Total gain			836.5	Total gain		748.25

The Duroc Jersey pigs were weaned during the week ending May 18, and the Poland China during the week ending May 25. The former were fifty-nine days old when weaned and the latter forty-nine. The sows were removed from the pigs for longer periods on consecutive days and gradually dried off. The amount of milk required to support eight or nine thrifty, vigorous and rapidly growing pigs is by no means small and for the sake of the udder of the sow and the good of the young pigs the weaning was carefully done. Sows should be selected not alone for their forms and prolificacy, their milk-giving qualities should also be considered. Before the birth of the pigs the sows should be fed not to fatten them with a ration of corn alone, but to develop good, strong, healthy pigs. This may be best done by allowing plenty of exercise in the open field and by feeding a variety of foods. The sows in this case had been fed on practically the same ration before the birth of the pigs that they received afterwards, and as a necessary consequence the pigs came healthy and able to take care of themselves. There were no weaklings in either litter. Moreover, the continuance of the feed after the birth of the pigs to which the sows were accustomed before, rendered unnecessary any sudden and extreme change of feed at that critical time. Naturally the sows were fed sparingly for a few days, both before and after the pigs came, to prevent congestion of the udder.

Among the Duroc pigs the one that made the greatest total gain was one of the larger pigs on the start. On the other hand, pigs number five and seven were the smallest pigs in the litter when first weighed and remained the smallest throughout, making the lightest gains.

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The Poland China litter was very even both on the start and in their after growth, although pigs number seven, four and nine were the heaviest at the beginning and remained so to the end of the test.

The record of the feeding of the Duroc pigs extends back but four weeks before weaning. In the next table there is given the gains of the sows and pigs for the four weeks before weaning, the feed eaten, the dry matter in the feed and the amounts of the different constituents of the feed required to produce a hundred pounds of gain. For comparison the same facts are given for the four weeks immediately following weaning and finally for the last four weeks of the feeding period, ending August 10.

In computing the cost of the gain, the values of the feeding stuffs in the Lansing markets are used, viz.: Corn meal, 45 cents per hundred; middlings, 50 cents per hundred, and skim milk 20 cents per hundred.

TABLE III.—*Comparison of gains and food consumption before and after weaning.*

Period.	Gains.	Total food eaten.			Total dry matter.	Dry matter per 1 lb. gain.	Required for 100 lbs. gain.			
		Corn.	Middlings.	Milk.			Corn.	Middlings.	Milk.	Cost.
Duroc Jersey:										
Before	185.0	93.69	187.37	1,817.5	422.64	2.28	50.6	101.2	982.4	$2 69
After	195.8	126.58	253.16	1,845.5	512.78	2.62	64.6	129.3	942.5	2 83
Last	218.03	242.33	484.66	1,480.0	784.00	3.60	111.2	222.4	678.9	2 97
Poland China:										
Before	98.25	80.33	160.66	1,196.0	337.63	3.33	81.8	163.6	1,217.2	$3 62
After	202.0	101.83	203.65	1,574.0	420.83	2.08	50.4	100.8	779.2	2 29
Last	231.5	214.99	429.98	1,255.0	689.99	2.98	92.9	185.8	542.1	2 42
Averages		Before weaning				2.80				$3 15
		After weaning				2.35				2 56
		Last four weeks				3.29				2 69

Both sows lost heavily in weight during the four weeks immediately preceding the weaning of the pigs. The Duroc Jersey lost 11.5 pounds, and the Poland China 25 pounds. This extra shrinkage on the part of the latter sow very largely accounts for the increased cost of production of the gains in the four weeks preceding weaning. The pigs gained 122.8 pounds in these four weeks and disregarding the loss of weight by the sow, they made a pound of gain from 2.66 pounds of dry matter and at a cost of but $2.80 per hundred.

The fluctuations in the weights of the sows were great, owing undoubtedly largely to variations in bowel contents. They were exceedingly voracious and it was impossible to so control them before weighing as to get the conditions exactly alike each time. Moreover, it is in the natural order of things that the fat stored up in their bodies while pregnant should be utilized to furnish nourishment to the young pigs, resulting in a rapid loss of weight.

Taking all these facts into consideration the results of the test warrant the conclusion that *it costs but little more to make growth on pigs before weaning than afterwards.*

Professor Henry, at the Wisconsin Experiment Station, performed several experiments on the same point. From his work the following table is taken (Seventh An. Rept. Wisconsin Station, page 51):

TABLE IV.—*Showing the amount and cost of food required for 100 pounds gain.*

Lots.	Sows and pigs before weaning.				Pigs after weaning.			
	Corn.	Milk.	Shorts.	Cost.	Corn.	Milk.	Shorts.	Cost.
Lot II	184	483	....	$1 79	187	563	....	$1 96
" III	116	....	232	1 68	115	....	230	1 67
Average	....	....	....	$1.735	....	....	....	$1.815

For the sake of comparison with our results above, the cost of the gains have been computed on the same basis, viz.: Corn at 45 cents per hundred, shorts or middlings at 50 cents and milk at 20 cents per hundred.

For farther study the results of four other trials at the same station are given in the next table, taken from the same report, page 52.

TABLE V.—*Showing the amount and cost of feed for 100 pounds gain.*

Lots.	Sows and pigs before weaning.			Pigs after weaning.		
	Meal.	Milk.	Cost.	Meal.	Milk.	Cost.
Lot I	241	563	$2 26	251	587	$2 36
" II	288	649	2 66	215	577	2 17
" III	198	654	2 25	313	449	1 91
" IV	240	528	2 19	177	542	1 93
Average	242	598	$2 34	214	539	$2 09

Commenting on these two tables Professor Henry says: "It will be seen that this year (Table IV) we produced gain somewhat cheaper while the pigs were with the sow than after they were weaned, while last year the reverse was the case. Averaging the trials for the two years we have a difference so small that it may be entirely set aside by the results of further investigations."

In the following table is set forth by weeks the amount of each food constituent of the ration consumed by each litter of pigs, the total dry matter consumed, gain of pigs and pounds of dry matter consumed per pound of gain:

TABLE VI.—*Duroc Jersey, 8 pigs; pigs weaned May 18th.*

Week ending	Corn meal. Lbs.	Mid-dlings. Lbs.	Skim milk. Lbs.	Total dry matter. Lbs.	Gain. Lbs.	Dry matter per 1 lb. gain.
April 20	27.69	55.38	455.5	117.07	35.5	3.29
" 27	17.00	34.00	358.0	78.98	29.5	2.66
May 4	24.50	49.00	484.0	111.85	47.4	2.34
" 11	24.50	49.00	525.0	115.29	55.6	2.07
" 18, sow	13.75	27.50	264.5	61.81	....	....
" 18, pigs	12.41	24.83	337.0	65.24	38.75	1.68
" 25	28.58	57.16	517.5	125.38	67.75	1.85
June 1	31.50	63.00	510.0	132.41	55.0	2.40
" 8	31.5	63.00	418.0	123.88	38.00	3.26
" 15	35.00	70.00	400.0	131.11	35.0	3.74
" 22	37.33	74.66	520.0	148.81	82.0	1.81
" 29	42.00	84.00	570.0	165.98	58.5	2.83
July 6	39.33	78.66	485.9	150.75	42.5	3.54
" 13	41.85	83.70	425.0	151.66	33.0	4.59
" 20	49.00	98.00	400.0	168.20	72.0	2.33
" 27	60.00	120.00	390.0	196.38	42.5	4.62
August 3	63.33	126.66	360.0	202.33	48.0	4.21
" 10	70.00	140.00	330.0	217.11	55.5	3.91

The next table records the corresponding facts for the Poland China pigs.

TABLE VII.—*Poland China, 9 pigs; pigs weaned May 25th.*

Week ending	Corn meal. Lbs.	Mid-dlings. Lbs.	Skim milk. Lbs.	Total dry matter. Lbs.	Gain. Lbs.	Dry matter per 1 lb. gain.
April 20	26.87	53.74	589.5	122.97	22.25	5.52
" 27	17.00	34.00	241.0	68.18	13.00	5.24
May 4	21.00	42.00	252.0	79.82	28.50	2.80
" 11	21.00	42.00	315.0	85.87	39.5	2.17
" 18	21.33	42.66	333.0	93.75	41.75	2.24
" 25, sow	13.33	26.66	249.0	59.21	....	....
" 25, pigs	15.42	30.84	239.5	68.59	47.25	1.45
June 1	22.16	44.32	359.0	93.16	45.5	2.05
" 8	21.00	42.00	315.0	85.87	40.5	2.12
" 15	28.00	56.00	495.0	121.69	48.5	2.51
" 22	30.66	61.33	405.0	120.11	67.5	1.77
" 29	35.00	70.00	495.0	140.24	42.5	3.30
July 6	32.33	64.66	393.0	123.38	49.0	2.52
" 13	34.33	68.66	330.0	121.66	31.0	3.92
" 20	42.00	84.00	350.0	144.86	64.5	2.24
" 27	53.33	106.66	300.0	170.07	52.0	3.27
August 3	56.33	112.66	350.0	182.33	53.5	3.41
" 10	63.33	126.66	255.0	192.24	61.5	3.12

Table II shows that taking the entire time from the thirteenth of April to weaning as a whole, neither sow gained or lost a material amount. In the above tables, therefore, the weights of the sows have been disregarded and the gains of the pigs alone considered, hence the variation between the amounts of dry matter recorded per pound of gain for the first weeks of these tables and the amount given in Table III where the net gain of the sow and pigs taken together are given.

The fact that young animals of all kinds make gains more economically than older and heavier ones has already been shown by a host of experiments. It is confirmed by the tables last given. Comparing the amount of dry matter eaten per pound of gain before the pigs weighed 50 pounds each with the corresponding amounts when the pigs were gaining from 50 pounds in weight to 100 pounds, and again when they weighed over 100 pounds, we find that the Duroc Jerseys required but 2.44 pounds of dry matter to make a pound of gain before they averaged 50 pounds; 3.06 pounds of dry matter per pound of gain between 50 and 100 pounds and 4.23 pounds of dry matter per pound of gain after the pigs averaged 100 pounds in weight.

Owing to the shrinkage in the weight of the sow before the pigs were weaned, the Poland China pigs do not show the point so clearly, but even with them it required but 2.93 pounds of dry matter on the average to make a pound of gain before they weighed 50 pounds apiece as against 3.11 pounds thereafter.

Compiling the results of 21 trials at this station and elsewhere involving the feeding of 87 animals for periods varying from 30 to 135 days in which the feed was composed of skim milk and corn meal, and 10 trials, using 60 animals with pigs under 50 pounds in which the feed consisted of skim milk, corn meal and middlings, it is shown that for the weights given the pounds of dry matter required to produce a pound of gain was as follows:

For pigs weighing less than 50 pounds		2.57	pounds.
" " " " " 100 "	and over 50	2.39	"
" " " " " 150 "	" " 100	3.16	"
" " " " " 200 "	" " 150	3.27	"
" " " over 200 "		3.90	"

These figures indicate that the older and heavier pigs grow, the greater the amount of feed it takes to maintain them and the less profit in keeping them. The period before the pigs weigh 50 pounds is an exception, but it must be remembered that during this period the pig is weaned and is subjected to other adverse conditions against which he is less able to battle, facts which account for the slightly larger food requirements at that time.

II. Gains of Pigs and Calves Compared.

To compare the food cost of a hundred pounds of gain of pigs with that of calves the gains and feed consumed by two calves were weighed and recorded. One of the calves was a thoroughbred Holstein bull and the other a Brown Swiss heifer, both 11 days old when the experiment began.

The record of their feed and gains are given in the following table. The grain ration consisted of a mixture of one part oil meal, two parts oats and two parts bran, fed dry. They were also given what clover hay they would eat.

The test began on the fourteenth of April. Up to the middle of May the calves had nothing but separator skim milk, as they refused to eat either hay or grain. The amounts of the latter eaten thereafter are given in the tables. After June 24, the Holstein calf had whole milk instead of skim milk.

Table VIII.—*Showing by weeks the weights of calves, gains, grain, hay and milk consumed, total dry matter therein and pounds of dry matter per pound of gain.*

HOLSTEIN.

Week ending.	Weight. Lbs.	Gain. Lbs.	Grain. Lbs.	Hay. Lbs.	Milk. Lbs.	Dry matter. Total. Lbs.	Pounds dry matter to 1 pound of gain.
April 14	119.						
" 21	130.	11.			130.5	13.39	1.22
" 28	141.	11.			146.5	14.06	1.28
May 5	150.5	9.5			141.5	13.58	1.43
" 12	161.	10.5	2.5	1.6	139.5	16.96	1.61
" 19	170.	9.	2.5	1.6	148.0	17.83	1.98
" 26	184.5	14.5	2.5	1.6	164.0	19.83	1.36
June 2	200.	15.5	3.5	2.25	178.0	22.09	1.43
" 9	214.	14.	.68	4.	204.5	23.63	1.68
" 16	222.	8.	5.27	3.5	204.0	27.62	3.45
" 23	242.	20.	2.57	3.0	214.0	26.17	1.30
" 30	256.	14.	2.50	1.5	231.5	25.68	1.83
July 7	263.	7.	1.50	1.	224.0	24.57	3.51
" 14	280.	17.	4.00	3.	224.0	28.47	1.67
" 21	302.	22.	7.00	5.	224.0	32.81	1.49
" 28	323.	21.	19.00	9.	226.0	47.03	2.24
Aug. 4	347.	24.	12.00	9.	224.0	40.61	1.69
" 10 (six days)	364.	17.	11.00	11.	192.0	38.21	2.24

BROWN SWISS.

Week ending.	Weight. Lbs.	Gain. Lbs.	Grain. Lbs.	Hay. Lbs.	Milk. Lbs.	Dry matter. Total. Lbs.	Pounds dry matter to 1 lb. gain.
April 14	105.5	....	....	....	....	....	....
" 21	115.75	10.25	....	....	130.75	12.75	1.24
" 28	123.75	8.00	....	....	143.50	13.78	1.72
May 5	132.0	8.25	....	....	133.00	13.25	1.66
" 12	135.0	3.00	2.5	1.6	133.00	16.84	5.61
" 19	148.0	13.00	2.5	1.6	140.00	17.03	1.31
" 26	158.0	10.00	2.5	1.6	161.00	19.05	1.90
June 2	168.0	10.00	3.0	2.25	172.00	20.21	2.02
" 9	176.0	8.00	5.25	2.75	188.00	25.02	3.13
" 16	193.0	17.00	5.25	1.75	200.00	25.33	1.49
" 23	210.0	17.00	5.50	2.00	211.00	26.83	1.58
" 30	223.0	13.00	6.50	3.25	192.50	26.98	2.07
July 7	220.0	-3.00	5.50	2.50	206.00	26.77	....
" 14	239.0	19.00	10.50	4.00	206.50	32.51	*3.70
" 21	252.0	13.00	11.00	6.50	211.00	35.05	2.69
" 28	263.0	11.00	14.00	7.50	209.00	38.79	3.53
Aug. 4	281.0	18.00	16.50	10.50	209.50	43.58	2.43
" 10 (six days)	292.0	11.00	15.50	9.00	180.00	38.61	3.51

*Average for two weeks.

The gains of both calves were irregular from week to week, due perhaps more to variation in the contents of the bowels than to differences in the weight of carcass itself. In the following table the gains, average dry matter per pound of gain, and the average amounts of feed required to produce 100 pounds of gain are given for the two calves for periods of five weeks.

TABLE IX.—*Showing food required for 100 pounds of gain.*

Five weeks ending	BROWN SWISS. Total gain. Lbs.	Dry matter per 1 lb. gain.	Required per 100 pounds gain. Milk. Lbs.	Grain. Lbs.	Hay. Lbs.	HOLSTEIN. Total gain. Lbs.	Dry matter per 1 lb. gain.	Required per 100 pounds gain. Milk. Lbs.	Grain. Lbs.	Hay. Lbs.
May 19	42.5	1.73	1,388	12	7	51	1.49	1,392	10	6
June 23	63.0	1.89	1,506	33	17	72	1.65	1,464	20	20
July 28	53.0	3.02	1,934	90	45	81	1.95	1,630	42	24
Aug. 10	29.0	2.83	1,343	110	67	41	1.92	1,015	56	50

These calves were able to make gains on a very low consumption of dry matter. The Holstein, having fresh milk unskimmed after the 23d of June, continued to put on flesh at a food expenditure of not quite two pounds of dry matter per pound of gain, certainly a very creditable performance.

In the following table a comparison is made between the average amount of grain and milk required by the Duroc Jersey and Poland China pigs in the three periods reported in Table III for 100 pounds of gain and the average amount of milk, hay and grain required for 100 pounds of gain by the Brown Swiss and Holstein calves.

TABLE X.—*Pigs and calves compared.*

	Required for 100 pounds of gain.			
	Milk. Lbs.	Grain. Lbs.	Hay. Lbs.	Dry matter. Lbs.
Duroc Jersey pigs	867.9	226.4	....	268.28
Poland China pigs	846.2	235.1	....	280.00
Holstein, skim milk	1,428.0	15.0	12	161.84
Holstein, whole milk	1,323.0	49.0	87	208.94
Brown Swiss	1,542.0	61.0	84	280.88

The pigs and calves in these experiments were subjected to the same conditions of weather and treatment. Their grain ration was different. The pigs demanded a very much larger proportion of grain to milk than the calves.

Keeping these facts in mind the conclusion that the calves put on their gains at an appreciably less expenditure of dry matter will not be misinterpreted. The Holstein required more dry matter when consuming whole milk than skim milk, simply because he was older at the time he received it. While both calves were healthy and thrifty the fact that the Holstein made more economical gains than the Brown Swiss is worthy of note.

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GLOSSARY.

Aërobes.—Bacteria which require free oxygen.

Agar-Agar.—A preparation of dried sea weed found on the eastern coast of Asia.

Anaërobes.—Bacteria which will not live where there are traces of free oxygen.

Arthrospores.—Bacterial cells which assume the characteristics of spores.

Asporogenic.—Applied to bacteria incapable of producing spores.

Bacillus (plural, bacilli).—A rod-shaped micro-organism.

Bacteria (singular, bacterium).—A generic name representing the entire class of micro-organisms.

Bacterium.—In the generic sense the singular of bacteria; in specific sense, a very short rod or bacillus.

Biological.—Pertaining to the study of life.

Blood-corpuscles.—Circular cells existing in blood.

Blood serum.—The straw colored liquid expressed from blood clot.

Bouillon.—A beef tea containing dry peptones.

Brownian motion.—A vibratory motion.

Capsules.—A gelatinous substance enveloping bacteria.

Carbon.—A chemical element entering into the composition of all organic compounds.

Cell.—The ultimate division of organized living matter.

Cellulose.—A woody fiber-like substance.

Cell-wall.—A sheath enveloping a cell.

Chain.—Several micrococci joined together as a string of beads.

Chromogenic.—Applied to bacteria producing pigment.

Cilia (singular, cilium).—Lash-like appendages.

Clostridium.—Designates an enlargement at the middle of a bacillus, produced by the formation of a spore.

Colony.—An aggregation of bacteria springing from a single micro-organism.

Culture.—Bacteria under cultivation in a suitable soil.

Diplococcus (plural, diplococci).—A kind of micrococci arranged in pairs.

Disinfection.—A process by which pathogenic bacteria are rendered inactive, or killed.

Endospores.—Spores formed within a cell.

Fermentation.—A process of chemical change instituted by a ferment as produced by yeasts or bacteria.

Fission.—The constriction of the cell-wall in the process of multiplication.

Flagella (singular flagellum).—Same as cilia.

Fungus (plural fungi).—A low form of plant life free from green pigment (chlorophyll); it obtains its substance from organic matter.

Gelatin.—A jelly like substance obtained from animal tissues.

Germ.—That from which vegetable or animal life develops. Is frequently used as a synonym of microbe.

Germination.—The process of development which the germ undergoes.

Hanging-drop.—A small drop of fluid in which bacteria are suspended for the study of their natural condition.

Homogeneous.—Uniform consistency throughout.

Hydrogen.—A chemical element occupying an important place in organic chemistry.

Incubator.—An apparatus for holding an even temperature during an indefinite period.

Maximum.—The highest.

Medium.—A material for the cultivation of bacteria.

Microbes (singular, microbe).—Same as bacteria.

Micrococcus (plural, micrococci).—Spherical bacteria.

Micro-organisms.—Same as bacteria.

Micro-millemeter.—One twenty-five thousandth of an inch.

Minimum.—The lowest.

Morphology.—The study of form.

Moulds.—A class of fungi.

Nidus.—A nest or home.

Nucleus.—A very dense and essential portion of a cell.

Optimum.—Best.

Oxygen.—A chemical element widely distributed through nature.

Pasteurization.—The process of eliminating most bacteria.

Parasitic.—Applied to those bacteria existing on living matter.

Pathogenic.—Applied to those bacteria producing disease.

Peptones.—Digested muscle fiber.

Petri-dish.—A dish used for plating.

Photogenic.—Applied to bacteria emitting light.

Plate.—A piece of glass upon which solid media are spread for the isolation of different species of bacteria.

Platinum.—A white metal withstanding a high degree of heat.

Proteid.—An albuminous substance.

Protoplasm.—A semi-fluid, translucent material found in the body of all living cells.

Real Motion.—Motion from place to place.

Refringent.—Refractive, glistening.

Saprogenic.—Applied to bacteria producing putrefaction.

Saprophytic.—Applied to bacteria living on dead matter.

Sarcine.—Micrococci grouped in cube-shaped masses.

Spirillum (plural, spirilla).—Screw shaped micro-organisms.

Sporadic.—Isolated.

Spore.—Oval glistening body inside of the bacterial cell.

Spore-wall.—The dense sheath covering the spore.

Staphylococcus.—A species of micrococci arranged in grape-like clusters.

Sterilization.—The process of killing or removing all bacteria.

Streptococcus.—A species of micrococci arranged in chains.

Tetrad.—A grouping of four micrococci.

Threads.—The joining of bacilli end to end in rows.

Toxicogenic.—Applied to bacteria producing poisons.

Translucent.—Semi-transparent.

Vegetative cell.—Cell capable of multiplying,

Vibrio.—A comma shaped micro-organism.

Yeasts.—Uni cellular plants which multiply by budding.

Zoöglea.—A massing of bacteria by means of an adhesive cell wall.

Zymogenic.—Applied to bacteria producing fermentation.

BACTERIA—WHAT THEY ARE, WHAT THEY DO, AND HOW THEY ARE CULTIVATED.

C. E. MARSHALL.

INTRODUCTION.

The science of bacteriology has entered into such an intimate relation with the farmer, because of its connection with the dairy, the soil, the silo, the diseases of animals and plants, and his surroundings, that some knowledge of it becomes indispensable to him. Thus far he has been met with reports and treatises of a technical or semi-technical character, simply because reports and treatises assume that an elementary knowledge of this subject exists, and because a report or treatise cannot be written absolutely free from terms of a technical nature. Explanations are not satisfactory where they are short and unsystematic.

The Michigan experiment station shall strive to make the work in bacteriology useful to every man who can read the English language and is interested in the matters of which this science treats. To accomplish this object, short and simply written bulletins will be issued from time to time, paving the way for the reports of experiments which must be of a semi-scientific character from their very nature. It is desired that these bulletins be near at hand for immediate reference and that they be wide enough in scope to answer and explain the various questions which naturally arise from a perusal of bulletins and in practical life.

In a few words, a general survey of bacteriology, covering those phases of the science especially applicable to agricultural interests, will be undertaken.

TERMS.

Some confusion prevails in regard to the terms applied to the organisms constituting the class of life included in bacteriology. Perhaps the most specific general term in use and most representative is bacteria, that which enters into the formation of the term bacteriology; yet a term so significant as micro-organisms—small organisms—must not be disregarded Again we find in the word, microbes, about the same fullness of meaning as in micro-organisms. Sometimes the most non-specific term, germs, is employed, evidently because it is short and euphonious, rather than from any value it possesses in this connection.

Bacteria.

Micro-organisms.

Microbes.

Germs.

THE SCIENCE OF BACTERIOLOGY.

Bacteriology has for its aim the study of bacteria, in their morphological and chemical aspects. Often the yeasts occupy a share of the science along with certain moulds, probably for no other reasons than their close relations to bacteria and the similarity of the methods used for the study of each. Yeast fermentations have always been associated with the study of bacteria. Pasteur united them under one common and natural department of experimentation by his early labors upon fermentation.

WHAT ARE BACTERIA?

It is not safe to attempt a definition inasmuch as many modifications would be necessary. A few of their characteristics may be mentioned, and these will convey to the reader sufficent data to formulate in his own mind a satisfactory notion of these minute forms of life. They are unicellular plants; that is, instead of possessing a complex structure of many cells, as the plants visible to the naked eye, they are but single cells, translucent, and have a definite form. In their multiplication, one cell divides and produces two, each of these two divides and both together produce four. A yeast cell, instead of multiplying by division or fission, increases by

Definition. Bacteria.

Yeast.

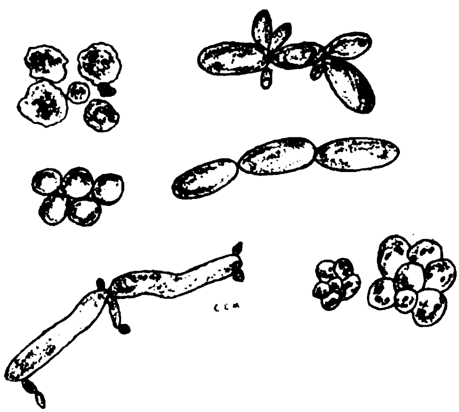

Fig. 1. Yeast cells.

budding. From the parent cell buds off a daughter cell, smaller than the parent cell. In moulds the growth is much like twigs, with the formation of long thread-like shoots.

Moulds.

CLASSIFICATION OF BACTERIA.

In the animal and plant kingdoms classifications are based largely upon anatomical structures and physiological functions. Form does not take a part to any great extent. Owing to ignorance of the structure and functions of the bacterial cell, a classification based upon them is infeasible; consequently the classification rests entirely upon the form which is easily studied. Three distinct forms exist. The first is a rod shaped cell, called a bacillus—plural, bacilli. Conceive little translucent rods, with rounded, tapering or square ends,

Bacillus Shape.

the length of which is two to ten times the thickness of the rod. The length of any species varies considerably, yet it has its limitations. The diameter of the rod is more likely to remain constant, still this will vary slightly. The figures just pointed out indicating the ratio of thickness to length, bearing in mind the constancy of the diameter, will illustrate the possibility

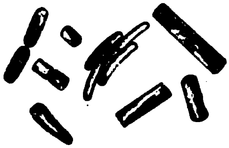

Fig. 2. Bacilli.

Size. of variation. The size of these cells is measured by a unit called a micro-millimeter or micron, which is equal to $\frac{1}{1000}$th millimeter, or about $\frac{1}{25000}$th inch. This unit is indicated by the Greek letter mu. m. The length of a bacillus will vary from one to ten microns. The bacillus which causes tuberculosis measures about 2 m. or $\frac{2}{25000}$th inch in length; that is, considering the human red blood corpuscles equal to $\frac{1}{3200}$th inch in diameter, it would require nearly four bacilli arranged in a row end to end to reach across the cell. It is possible to distinguish markings of $\frac{1}{200}$th inch with the naked eye. In order to make a thread of bacilli as above, that would correspond to the $\frac{1}{200}$th inch, sixty-two and one half bacilli would be needed. There may be several hundred thousand of these bacilli confined within a drop of water. Some bacilli are much longer and larger than the tubercle bacillus, and there are others much smaller. A rod, straight, whose length is greater than its diameter, is usually called a bacillus. To a short, thick

Bacterium. rod whose length is about equal to its diameter, the term *bacterium* has been applied. In this sense it is used specifically, but is also employed generically as the singular of bacteria.

Micrococcus. Coördinate with bacillus in the classification based upon form is the micrococcus, a small sphere. Instead of being a rod

Shape. shaped organism, as the bacillus, the micrococcus is round and ball shaped. The size of a micrococcus does not vary so much as a bacillus, yet it is not constant.

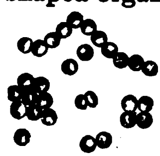

Fig. 3. Micrococci.

Size. Some micrococci are much larger than others, still the average micrococci have a diameter which is about equal to the diameter of a bacillus. One micron indicates about the average diameter of each. To illustrate, it would take 25,000 micrococci arranged as a string of beads to equal in length the diameter of a medium sized plum. These cells are not always perfectly spherical, but may be almost cube shaped, compressed on several sides, or they may be biscuit shaped or may be pointed on opposite sides.

Spirillum. Along with bacilli and micrococci is another form which

Shape. completes this classification. This form is screw shaped or spiral; the screw of a corkscrew fairly represents this form. Such micro-organisms are known as spirilla, the singu-

Fig. 4. Spirilla.

Size. lar of which is spirillum. The lengths of these bacteria vary more than any of the other forms. They may be much longer than any of the bacilli and again may not exceed some of the shorter in length. There are many of

Vibrio. the spirilla made up of segments, one segment consisting of only one curve of the spiral. When a segment of this kind exists by itself,

forming a complete organism, it is usually called a *vibrio*. Thus we speak of the micro-organisms of Asiatic cholera—the vibrio of Asiatic cholera. Classification:

1. Bacillus—bacilli—rod shaped micro-organisms.
   a. Bacterium—short, thick micro-organism.
2. Micrococcus—micrococci—spherical micro-organism.
3. Spirillum—spirilla—spiral micro-organisms.
   a. Vibrios—single curved micro-organisms.

PROTOPLASM.

The contents of a bacterial cell are normally homogeneous, translucent, and refringent, corresponding closely to the protoplasm, a semi-fluid and almost transparent mass, found in other living cells. So far as known the cell possesses no nucleus; still evidences of its existence are present. While the protoplasm is usually homogeneous, there are conditions when the opposite will prevail. Laboratory workers are acquainted with certain changes in the protoplasm induced by unfavorable media upon which they grow, by the direct rays of the sun, by a high degree of heat, and by certain chemicals. These agents are artificial. A natural change in the protoplasm occurs when the cell enters the stage of spore production. The protoplasm will then break up into different sized granules which move towards the center and coalesce.

Appearance.

Nucleus.

CELL WALL.

The sheath which encloses the protoplasm is of great interest as well as importance. Its composition seems to be that of woody fiber, cellulose, as has been established by micro chemists. The demonstration of it is dependent largely upon inference and analogy. Owing to certain peculiar arrangements of bacteria and the linking of cells, it does not seem possible that such could occur unless the cell be sheathed. Again, by the action of iodine, the protoplasm can be made to retract from the cell wall, leaving it behind, unassociated with anything, as a well defined line. With certain species the cell wall becomes enlarged resembling a gelatinous mass. When this is characteristic of a species, it is spoken of as a capsulated micro-organism. The great importance belonging to the cell walls of bacteria is their power to resist external agents of destruction. While the cell wall of one species will resist a comparatively high degree of heat or low degree of cold, that of another seems to have no resisting power at all. Someone may ask whether this power of resistance does not lie in some other portion of the cell structure; perhaps it does, but the indications lead us to believe that the cell wall is the greatest factor. More light will be shed upon this matter as we proceed. At this point a consideration of motion and flagella will be fitting.

Composition.

Demonstration.

Capsules.

Resistance.

MOTION

Many bacteria move and their motions differ. One species has a tumbling motion through the liquid in which it is suspended, another a darting motion, and still another a snake-

Kinds.

like motion, all of which are progressive, moving from one place to another. These bacteria possess actual motion. There are other bacteria which have only a vibratory motion, or an up and down motion, but do not move from one place to another. This kind of motion is known as Brownian motion. Again, there are other bacteria which remain absolutely still.

Actual.

Brownian.

FLAGELLA.

Associated with actual motion in bacteria are organs of propulsion, called flagella, cilia, and even whips, because they are whip-like appendages. From some of their reactions to stains, they resemble the structure of the cell wall, and may be merely a continuation; yet if they really are concerned in the movements, it would seem more plausible to consider protoplasm as part of their structure. Bacteria differ widely in the arrangement of their flagella. The bacillus may have but one flagellum or it may have numerous flagella. When possessing only one, it is placed at the end, but if many, they radiate from all sides. In the micrococcus the whip proceeds from the side. Very few micrococci are known to have whips. The true spirilla possess a bunch of flagella at each end, and the vibrio a single whip at the end. The ordinary flagella are three to ten or twelve times the length of the micro-organism. In a few species, what are known as giant whips have been found which are forty to sixty times the length of the micro-organism.

Composition.

Arrangement.

Size.

Giant.

Fig. 5. Flagella.

SPORES.

In the discussion of protoplasm, reference was made to its condition just before the formation of the spore. It becomes granular and more refringent. The granules gradually proceed towards that portion of the cell, where the spore is in process of formation; there they coalesce, take on a membrane or sheath and assume the form of a spore. This spore may be located at the end of the cell, at the middle, or any place between the middle and the end. It may be wider than the cell, thus causing a bulging. In such a case, when the spore is located at the end, it will produce a club shaped or a drum stick shaped micro-organism. When the spore is in the middle and produces a bulging, it gives rise to the clostridium form. Wherever the spore is in the cell, it undergoes about the same life history. As soon as the cell has produced its spore, it will begin to disintegrate and eventually leave the spore free. This spore will not generally germinate when left in the same medium in which it was produced, but if transferred to a suitable medium will

Formation.

Location.

Germination.

Fig. 6. Spores.

develop into another cell; that is, a cell may produce a spore, but it dies in the act; yet it has its life continued through the spore which will in turn give rise to a cell. Sporulation does not mean multiplication but simply a transmission of life. When the spore germinates, it throws off the sheath enshrouding it and the young cell comes forth. This mode of formation, when the spore is within the cell, is called endospore formation. In this class the spores appear as bright oval bodies, highly refractive, much more so than the protoplasm of the cell, and markedly uniform. On the other hand, there are those cells which become more refringent as a whole, seem to resist staining reagents more than their associate bacteria, and in short to assume the qualities of a spore. Such spores if they do actually exist are called arthrospores. There are many bacteria in which no spore formation has been observed; for this reason this indefinite class of arthrospores has crept in; still it bears with it considerable valuable evidence. Certain spore bearing bacteria when grown under unfavorable conditions will cease to produce spores. Such bacteria are called asporogenic bacteria. The spore wall which breaks away when the young microbe starts on its career, is of the greatest importance in the bacteriological economy. It is perhaps one of the most resistant and impenetrable of substances making up plant life. Were it not for the spores, bacteria would be easily eradicated. They are exceedingly resistant to heat, sunlight, dessication, stains and chemicals. Spores are known which will resist twelve hours of steaming, will live for months in the direct rays of the sun, will endure for years in dust, will not react to ordinary staining methods, and will be unharmed after hours in a strong germicidal solution. This feature of the morphology of bacteria plays a decided rôle in bacteriology. The inability to sterilize milk is largely due to this characteristic of some bacteria; the continuous existence of anthrax in some localities is also based upon this fact. Spores are the most formidable obstacles a bacteriologist has to contend with.

Endospores.

Arthrospores.

Asporogenic.

Spore wall.

Resistance.

GROUPING OF BACTERIA.

Besides the classification of bacteria founded upon forms and spores, there is another not used so much to systematize bacteria, but to a considerable extent as a characteristic in the identification of species. Some bacilli always remain ununited with others of their kind; there are those which unite in pairs, the ends are contiguous to each other, and still those which form long threads or rows, united end to end. Again bacilli may have characteristic groupings; the bacillus of tuberculosis is generally arranged in clusters of three, four, or more bacilli, and the grouping of these bacilli is not peculiar to any other variety. With the micrococci, the groupings are more noticeable and pronounced. As with bacilli, micrococci may be arranged alone or in pairs and other groups. They are not especially designated when existing

Threads.

Fig. 7. Threads of bacilli.

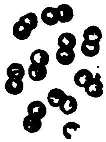

Fig. 8. Diplococci.

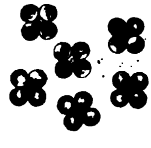

Fig. 9. Tetrads.

Diplococcus. alone, separated from others, but when united in pairs, they are called diplococci. Groups of fours are also quite common and to these groups the name, **Tetrad.** tetrads, is given. Another arrangement is where several of these tetrads are arranged and brought together so as to form a cube. These cube-like masses are **Sarcine.** sarcines. If micrococci are arranged together so that one follows the other in a line, they will have the appearance of a chain or a string of beads. **Streptococcus.** Cocci so joined are known as streptococci. They may be arranged in bunches looking much **Staphylococcus.** like a cluster of grapes; when so grouped they are called staphylococci. Bacteria in general are many times found in large masses visible to the naked eye, and are closely adherent to each other. Such masses are **Zoöglea.** zoöglea. This condition is usually produced by the structure of the cell wall in such cases. There seems to be a gelatinous substance surrounding the cell due to a hydrated condition of the cell wall.

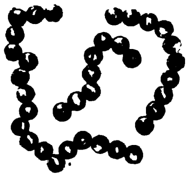

Fig. 10. Streptococci.

Fig. 11. Staphylococci.

FISSION.

The matter of fission or division in bacteria influences largely their arrangement or grouping. It is easy to conceive a bacillus dividing in two and these two in four and so on by constrictions which **Single Fission.** gradually separate the bacilli. If these constrictions are complete, the bacilli will appear single, if not they will form in threads. The same thing takes place with micrococci; if the constrictions are complete, they are single; if not complete, they form chains which correspond to threads of bacilli. By some authors these words thread and chain are used synonymously. Should a micrococcus divide and form two, a diplococcus would exist, but if these **Double Fission.** two should divide in a direction opposite to the first, a group of four or a tetrad would be formed. In this case there are divisions in two directions. Now consider a division of the **Tripple Fission.** cocci constituting the tetrad in a third direction, producing a cube shaped mass, the resulting group would be a sarcine. **Multiplication.** Through fission, multiplication of bacteria occurs. When placed under proper conditions it is very rapid, in some species every half hour. This increase in a geometrical ratio conveys some notion of the number of bacteria one micro-organism will give rise to in the course of twenty-four hours. The multiplication would be like this:

At the beginning there is one bacillus.
" " end of the first half hour there will be two bacilli.
" " " " " second " " " " " four "
" " " " " third " " " " " eight "
" " " " " fourth " " " " " sixteen bacilli.
" " " " " fifth " " " " " thirty-two bacilli.
" " " " " sixth " " " " " sixty-four "
" " " " " seventh half hour there will be one hundred twenty-

eight bacilli. This is three hours and one-half from the beginning of the multiplication. At the end of the tenth hour, following out the same ratio of increase, there will be one million one hundred seventy-six thousand five hundred and seventy-six. Computations made concerning the multiplication of one micro-organism for a week's time, provided everything were favorable, give startling results.

Classification according to fission:

1. Bacilli:
   a. Threads—bacilli united end to end in a row.
2. Micrococci:
   a. Diplococci—micrococci arranged in pairs.
   b. Tetrads— " " " fours.
   c. Sarcines— " " " cubes.
   d. Streptococci— " " " chains.
   e. Stapylococci— " " " clusters.

Zoöglea—the massing of bacteria.

LIFE REQUIREMENTS OF BACTERIA.

Like other plants bacteria demand proper conditions before they will develop; food suitable for their assimilation, moisture sufficient for complete solution of the food, a reaction neither strongly acid nor alkaline, and a proper temperature to favor their growth. Wheat will not grow unless these factors are observed. If the soil is void of richness, the grain of wheat sprouts and withers away; if moisture is wanting, it may not sprout at all; if the temperature is low, it scarcely grows; and if the reaction of the soil is wrong the life is stunted, as in the alkali tracts of the west. Wheat will grow in some soils while in others it is poisoned. Some fields will produce forty or fifty bushels to the acre, and other fields will merely return the seed. Again there are those plants which will grow where the wheat will not, illustrating the fact that each species of plants has its optimum soil. Just as with higher plants, so it is with bacteria. Some will grow well on a soil where others will not; on certain soils there are those which will not develop at all. Each species of bacteria has a soil which is best adapted to that species. There are however certain elements which are absolutely necessary to their growth and which must enter into their food.

Food. **Nitrogen.** Nitrogen is one of them. Remove all traces of nitrogen from their food and they will not grow. Absolutely pure fat will not undergo decomposition, neither will an absolutely pure sugar solution ferment. In fat there is no nitrogen and sugar is free from it. The sources of nitrogen are however numerous. When bacteria act upon a bald rock protruding above the ground, they do not gain their nitrogen supply from the rock but from traces of ammonia in the air and from the free nitrogen of the air. These substances which they gain from the air they convert into nitric and nitrous acids and utilize what nitrogen they need for their own economy. In the soil, decomposing organic matter, such as decaying plants, is present to furnish the required nitrogen. Water has enough nitrogenous material suspended in it and in solution to provide a rich nidus for the multiplication of bacteria. Disseminated

through the air, traces of nitrogenous compounds are found. No matter in what direction the attention is turned, there is sufficient nitrogen for the needs of bacteria.

Oxygen.

Oxygen is also essential to bacteria. Many of them require the free oxygen of the air the same as man; but others are poisoned by this same free oxygen; that is, there are those bacteria which will not grow in the presence of air. Two classes of bacteria therefore spring from their reactions to oxygen of the air, the one requiring this oxygen, the aërobic bacteria; the other poisoned by this free oxygen, the anaërobic bacteria. From this the conclusion must not be drawn that the free oxygen of the air is the only source for the aërobic bacteria, and that the anaërobic bacteria do without oxygen in any form; on the contrary both classes utilize oxygen in combination with other elements as found in organic matter.

Aërobic and Anaërobic.

Carbon.

Bacteria as a rule are unable to absorb carbonic acid gas as the higher plants with their chlorophyll, yet some of them are able to employ it in their functional processes. For their own sustenance they obtain their carbon along with the other elements in organic substances. This is also true of hydrogen, phosphorus, sulphur, and inorganic salts necessary to their development.

Hydrogen, Phosphorus, Sulphur, etc.

Moisture.

No bacterial development occurs without the presence of moisture. Whenever the micro-organism finds a dry habitat it ceases to grow, although it may remain alive for days and months. Bacteria stand in need of moisture as much as the wheat plant. The spore, the most resistant form of the micro-organism, may lie dormant for years if moisture is absent. Like the grain of wheat, it will not germinate unless sufficient moisture prevails. Dust contains life, but it is not until it reaches a humid condition that it gives activity to the life within.

Temperature.

Bacteria differ widely in their relation to temperature, but every species has its minimum, optimum, and maximum; that is, there is a point so low at which a certain species will cease to grow and one so high that it will not develop, and between these extremes a point will be found at which this species will flourish best. Each species has its own minimum, optimum, and maximum temperature. Some bacteria will grow at 8° C. [46° F.] and others at 70° C. [166° F.]. As a rule, however, those found outside of the animal body will grow best at about 28° C. [82° F.] to 30° C. [86° F.], and those connected with infectious diseases require 37½° C. [98° F.] for their optimum. The tubercle bacillus develops only within a range of two degrees and others have a very narrow range of temperature, as the bacillus of glanders and the micrococcus of pneumonia; still most bacteria have a latitude of 15° or 20° in which they will grow. Meat kept below 15° C. [59° F.] will not decompose rapidly and milk will remain sweet much longer at this temperature, simply because the bacteria lie dormant and will not grow. Change in temperature is quickly noticed by bacteria.

Reaction.

Bacteria will not bear a strongly acid or alkaline solution. They may remain alive but refuse to grow. Some bacteria will grow in a slightly acid medium, but the reaction most favorable to bacteria as a class is neutral or slightly alkaline.

SAPROPHYTIC AND PARASITIC BACTERIA.

According to habitat, bacteria may be divided into two classes, saprophytic, those which live on dead matter; parasitic, those which live on living matter. Among the saprophytic are found the bacteria of the soil, air, and water, and any which do not find their natural conditions when living matter is present. On the other hand, a truly parasitic micro-organism will not live unless associated with life. Nearly all the bacteria producing infectious diseases are able to live on both living and dead material. There are no fast lines to be drawn in this matter of classification.

PATHOGENIC AND NON-PATHOGENIC BACTERIA.

The first of these produce disease by arresting certain functions of the organism or by a change in their tissues. Poisons emanating from this class of micro-organisms enter the circulation and give rise to the symtoms manifested in the disease. The non-pathogenic bacteria are unable to develop poisons or institute changes within the animal or plant economy.

DISTRIBUTION OF BACTERIA.

The requirements of bacteria indicate their distribution, for each factor entering into these requirements must determine the existence of bacteria in any geographical location. As an illustration of this, the factor, moisture, could be well employed. It has been said that moisture is essential to bacterial growth. Other conditions being suitable, where moisture is, bacterial growth will be abundant, without it, there will be no development whatever. Put away a piece of leather in a moist cellar, it will contract moisture and upon its surface will be noticed certain fungus growths; place it then in a dry atmosphere, the fungus growths will disappear. What explanation can be offered! The light may have some influence, yet leather will mould in light, if moisture is present, but will not mould if there is an absence of moisture. Bacteria act as the moulds. Remove the moisture from a piece of meat and it will keep indefinitely. Fruit is dried that it may keep any length of time; if moisture were to be supplied to that dried fruit, it would decompose within a few hours. Oats in a shock are safe against mould and decay till the rain provides moisture for the latent life that is ready to germinate. Consider for a moment the decomposition that is constantly in process. Organic matter everywhere will decay if moisture is present, take away the moisture and the decomposition will stop. There are certain localities where an animal will dry up, when falling dead, because the moisture is so rapidly evaporated that the bacteria will not have an opportunity to begin their operations of disintegration. Not far from this locality the opposite may exist. The animal will fall dead, and the bacteria will soon commence their work of disassociation; not long after the animal will be reduced to the ashes from which it sprang. Moisture, however, is only a factor in the distribution of bacteria and has been used merely to illustrate the importance of single factors in the determination of bacteria any where in nature. The other factors, food, temperature, reaction of media, each in turn could be shown to render a part in the distribution of bacteria, as important as moisture, but their importance will appear without especial illustration in the body of the discussion.

This subject presents treatment under three distinct heads, although a few media of distribution may scarcely be classified, and will accordingly be considered separately. These three heads are:

1. Air.
2. Water.
3. Soil.

Air. The air can hardly be regarded as a natural home for bacteria' notwithstanding the fact that many are found there. Most of the species found in the atmosphere are non-infectious; very few pathogenic bacteria have had their presence demonstrated by direct examination. Organic matter and moisture are the measure of bacterial life in the air about us. The dust which rises from the streets, laden with pulverized sputa of people with infectious diseases, and filled with the offal of horses, disseminates through the air a multitude of bacteria. The material conveyed directly to the air from the lungs of the inhabitants and the sweepings from houses and shops provide a fertile soil for bacteria. The ware-room where rags are handled and skins are carted about, numbers its victims every year, the one dying of cholera, the other of anthrax. The city has the largest number of bacteria, mid-ocean the smallest. Where life is so active and every foot covered by habitation, it is a natural result that the air of the city should furnish its equally dense proportion of life. Mid-ocean on the contrary has little opportunity of feeding micro-organisms although moisture may be in abundance. The air is consequently practically free from bacteria. The extremes have been 1 .wn. The country with its scattered dwellings, the plain with its single house, the mountain with its bare rock,—all of which appear mid-way between the city and mid-ocean,—are not able to muster a regiment of bacteria to antagonize man. There are the winds and currents of the air to carry these fine particles of life over miles of country. Cinders from a volcano have been estimated to pass through hundreds of miles of air before they fell, and cinders are hardly comparable with bacteria. It is impossible to state the influence of currents of air upon bacteria, yet it must be great. Influenced greatly as they may be by currents of air and wind, bacteria always gravitate towards the ground and will eventually reach the soil.

Water. Water may contain very many or very few bacteria; it rests wholly upon the kind and supply of food. Rivers flowing down the sides of mountains covered with dense wildernesses, lakes whose banks are free from inhabitants, and seas which measure thousands of miles in extent can boast of a scarcity of bacteria. There is but little decaying matter to be transported by these waters, and little opportunity for gathering sewage of habitable districts to supply the little nourishment required for the growth of bacteria. From the other side, view the conditions existing along streams in our thickly settled states where town after town pours its sewage into them and where there are only two or three miles intervening between the towns for purification; also regard the borders of our lakes, where large cities have their intake pipe for their water supply only a few yards away from the outlet of the sewerage system. The water about the shores of lakes is usually very quiet and there is little chance for bacterial life to vanish. Here is the best food imaginable for growing bacteria. The waters of such places are pregnant with these forms, some of which are detrimental and some harmless. Bacteria are associated with habitation; they are essential for the reduction of the organic wastes given

off by man, and nature has her way of disposing of them over which man has little control. It may be asked what condition is found in underground streams and wells. There are many springs which have their source deep in the earth, the fountain of whose water may or may not be free from contamination. Imagine two strata of rocks which emerge from the earth at a thickly inhabited district and rich in filth. From this spot the water may percolate through the soil between the strata of rocks and in time find its exit in a sparkling spring of water. It is a matter of quite common occurrence to find living infusoria in such water which are generally traceable to a source of surface water. How much easier it would be for bacteria to find their way! What applies to a spring, applies equally to a well; and many times wells are discovered to be the receptacle of a back-yard cesspool. Rain water is usually comparatively free from injurious bacteria, provided the cistern is clean and the first dash from the roof during a rain storm be turned into the waste pipes.

Soil. While in some respects soil does not bear so much interest as water, in others it conveys a richness of interest to our minds which neither air nor water has presented. In the early days of bacteriology little was thought of bacteria in connection with growing crops; now it promises to be one of the richest as well as most formidable branches of bacteriology. Every new fact that comes to light in connection with nitrifying bacteria signifies the possibilities of this line of work. When the farmer spreads broadcast his barnyard manure or his blacking upon his fields, he does not add so many chemical constituents as he does bacteria which will change his soil to profitable and utilizable fields. The nitrogen of nature which was growing so scarce before the eccentricities of the nitrifying bacteria were known, will doubtless cease to be a speculative element in the presence of this class of bacteria. Not only does the soil furnish nitrifying bacteria but also putrifying and other fermenting bacteria. In a heap of compost there will be found millions of bacteria at work upon the material forming it. Each species represents a specific function to a certain degree. The slops in the back-yard, the decaying matter stored in the cellar, the putrifying material scattered about the lot,—all are the homes of bacteria. The city soil, where there is so much filth, incubates bacteria day and night, and the ground is burdened with them. Here is the home of the tetanus bacillus which gives rise to lockjaw, here the typhoid bacillus sojourns, and here the source of many other infectious bacteria. A pasture upon which cattle diseased with anthrax have died may harbor the bacillus for years. The bacillus of blackleg also lives in the soil and finds its way into the tissues with little difficulty. Disseminated through the soil are bacteria of nearly every kind, from those useful to man to those the most detrimental. In the old inhabited districts of Europe, where filth has accumulated for centuries, some of these most injurious bacteria may be found in large numbers. In such localities it is not infrequent for a lad to run a rusty nail of the soil into his foot and die in a short time of lockjaw. The anthrax districts are well defined in Europe; maps are made designating the exact positions of these places. This is also true of blackleg, but the districts are not so well defined. There are sporadic cases which can usually be accounted for in each instance by some peculiar circumstances. A field unbroken by the plow and untrampled by animals with infectious diseases contains little danger from its supply of bacteria, for they are of the variety which do no harm pathogenically. Sandy tracts of land have few bacteria owing to the

scarcity of organic matter and in many cases of moisture. Moisture and organic matter in the soil govern the activity and change connected with it, and indicate the value of the land.

Animals and Plants. To make this heading coördinate with air, water, and soil, would be an illogical division, and to make it subordinate is not reasonable. It is distinct. Animals and plants shelter bacteria and influence their distribution so greatly that it may truthfully be said that they would have no distribution were it not for these agents. Diseases of animals, tuberculosis, for instance, would not extend from pole to pole, if it were not through the instrumentality of animals. Diseases of plants do not differ much in this respect. Established facts bear out this statement and point out the relation of bacteria to animals so far as distribution is concerned. Aside from animals and plants there are doubtless other means operating about which nothing is known. With the amount of work that is now under way, it is fair to predict that the avenues of travel used by bacteria will gradually become familiar to bacteriologists in the near future. Methods will be devised to intercept them in their movements.

BACTERIAL FUNCTIONS.

Meat placed away for a short time will often reveal red and yellow spots and in fact spots of almost any color.

Many have witnessed a pool of water which would change in color as a changeable silk, when viewing it from different places.

The phosphoresence of the sea has been marveled at repeatedly. All have heard about it if not seen it.

Every housewife is conversant with the methods of using yeast to make bread, and wonders how a bit of yeast will render light a panful of bread dough.

The dairyman waits for the souring of his milk with the same degree of assurance as he awaits the arising of the sun.

The farmer makes his cider and regrets that it becomes vinegar so quickly.

There are very few who have not looked over the surface of a swamp and seen air bubbles rising to the surface of the water.

Meat will decompose before it is consumed and in this condition it has been eaten to the detriment of health.

Villages have been poisoned by attending an ice cream festival or drinking the milk procured from a single milkman.

All these phenomena have come to the attention of everybody. Have they all a meaning and are they associated with bacteria? Some of them suggest a lengthy treatment, yet at this stage satisfaction will have to be gained from very brief statements, since in some of these matters future consideration will be given. When bacteria are studied in their above relations one simply studies their offices in nature, what they do and to what products they give rise. This part of bacteriology is one of the most useful, fruitful, and practical relations of bacteria. Perhaps the investigation of bacterial products has led to more beneficial results than any other line of the science. The suggestions made at the beginning of this subject upon functions only introduce us to a wide field of research.

Chromogenic Bacteria. For many years there has always been food for superstitious people in the fact that spots of blood would appear upon their meat or bread. They considered them to be drops of blood deposited there by some supernatural power. At other times

they have noticed that their milk was colored blue, red or green. Bacteria are at work producing pigments of various colors. They evidently secrete a substance which in contact with the oxygen of the air becomes colored.

In the water are found several species of bacteria which yield a product of marked fluorescence; various shades may be noticed in the progress of their growth.

Photogenic Bacteria.

There are bacteria which upon cultivation will produce sufficent light to note the time of night. There are plants which light up the sea.

In the making of bread the yeast plant is added for the purpose of fermentation. It probably gives rise to alcohol and carbonic acid gas; the alcohol evaporates when the heat is applied, and the carbonic acid gas renders the bread light by filling the dough with air spaces in its attempt to escape.

Zymogenic Bacteria.

Contained within cider is a sugar upon which the bacteria feed and change it eventually into alcohol, and this alcohol into acetic acid. In the evolution of acetic acid other products are formed on the way and along with acetic acid. While in many ways it is apparently simple, it is, in reality, a very complex process.

In the souring of milk, which follows very closely the yeast action in bread and the change of cider in vinegar, the sugar of milk is converted into an acid, called lactic acid, directly or indirectly, as the case may be, and which in turn precipitates or curdles the caseine.

Aërogenic Bacteria.

In swampy districts, underneath the water, there is usually more or less organic matter in process of decay instituted by bacteria. In their operations they eliminate various gases from this material. This gas rises to the surface of the water, producing the bubbles mentioned.

Saprogenic Bacteria.

This decaying or putrefying process is also found in meat under another form. Meat is composed of a very complex array of elements; a greater complication would be expected in the products, which would be somewhat different. The gases formed are of a different nature and often give rise to decided odors. Such smells as that of ammonia will be noticed, and of rotten eggs, due to hydrogen sulphide.

Toxicogenic Bacteria.

Intense poisons may also result from the action of these bacteria and if introduced into the system will give rise to serious trouble. The many fatal cases of poisoning from eating meat are generally traceable to decomposing bacteria.

The poisoning of milk or ice cream is much the same as meat poisoning and belongs to the same class.

LABORATORY WORK.

It may seem out of place to introduce into a simple treatise of the fundamental steps of bacteriology, a description of laboratory methods, yet an explanation will not be necessary if it is borne in mind that it is really a laboratory science; and for a successful interpretation of any article dealing with bacteria, a knowledge of the methods employed is obligatory. There is also another phase of this matter, which enhances the consideration of laboratory methods, and which, if kept in view, will lead to much practical good. This is a study of laboratory methods with the direct object of adapting them in modified forms to every-day life. If careful attention is given in the review, still another feature, accuracy in detail, will be observed in every step of an experiment. Accuracy is indeed the most essential quality to a successful worker in the laboratory.

It is a difficult task, even with the best illustrations, to describe apparatus. Without an idea of the apparatus, laboratory knowledge would be meaningless, and a comprehension of the work would be impossible. A description, therefore, of the apparatus, with a view mainly to state the principle involved, will be undertaken.

Laboratory work embraces the study of bacteria in all of their biological aspects, which signify their morphology, cultural properties, chemical products, and many other associated branches of observation. To accomplish this object it becomes necessary to enter into a consideration of means to an end. To make the subject as simple as possible, topics will be inspected in a light which will not cause much confusion. The complex apparatus will be compared with things already understood. In fact the every-day utensils about the house are embodied largely in bacteriological apparatus which are modified for convenience. These modifications are not essential for an understanding of the principle and may be entirely overlooked. Let us now attend to the laboratory work.

STERILIZATION.

From the bacteriological standpoint, sterilization is the process of rendering any substance free from bacteria; any way in which this may be done is a means of sterilization. It must not be confused, however, with such terms as Pasteurization or disinfection. Pasteurization refers to the process of reducing the number of bacteria by killing those most susceptible to a certain degree of heat; while disinfection is usually limited to pathogenic bacteria, and means either the killing or the reduction of their vitality.

Several methods are recognized in the accomplishment of sterilization. Because of the extensive application of sterilization to diverse objects and substances, it is readily seen that no method is desirable for all. They all have their particular advantages. Of the three general agents employed, heat, chemicals and filtration, heat undoubtedly occupies the foremost place.

Heat. This agent has been used since the embryonic days of bacteriology. It was then applied continuously for various lengths of time; but as shall be seen later, the experiments were not always successful. Thanks to Tyndall for the introduction of discontinuous heating, or what is commonly called fractional sterilization. Under the consideration of spores, it will be remembered that the spore wall was exceedingly resistant, much more so than the vegetative form; that some spores will withstand several hours of steam heating. Consequently it is sought to kill the vegetative form, which is done in a comparatively short time, and the spore is then allowed to develop. The process is this: When the bacteria in the vegetative form are killed the heat is discontinued and the spores are allowed to germinate. The bacteria resulting from this germination are then subjected to another heating of the same time and degree. This alternation of heating for the killing of bacteria, and cooling for the germination of spores is repeated two or three times, during which period all the spores germinate and the bacteria produced from them are exterminated. Two methods have been suggested of applying heat, continuous and discontinuous, of which the discontinuous is the most reliable. Wherever heat of a high degree is possible, continuous heating becomes feasible and even desirable in many instances.

Kinds. For sterilizing purposes, heat appears in two forms, moist and dry.

Boiling and steaming, without pressure, at 100° C. [212° F.], or with pressure at 125° C. [257 F.], illustrate the different manner of usage.

Boiling. Since boiling may be executed under most circumstances, and the apparatus for steaming is not common, the former, boiling, is the most worthy of consideration. The conditions are almost universally present to sterilize by boiling in the form of wash-boiler, kettle, pans, or almost any receptacle. If utensils can be boiled for one-half hour they are practically sterile; that is, they are about as sterile as it is possible to obtain open vessels which are to be used in the handling of exposed material. Occasionally spores are present which will resist this process, yet this is not the usual case. If bottles or pails are to be prepared for Pasteurized milk, no better means free from expense and trouble could be adopted. From the hygienic side, boiling is again exceedingly useful. Milk may be Pasteurized by boiling, and made free from infectious bacteria. To insure safety against the tubercle bacillus, diphtheria bacillus, or the typhoid bacillus, no better scheme could be devised than to bring the milk to the boiling point for a moment at least. Water, too, is often the host of the typhoid bacillus, cholera spirillum and occasionally of other infectious bacteria. To rid it of danger, boiling is all that is necessary. Contagious diseases often exist in families. The rooms where the patients live have curtains and carpets, the beds have linen and other coverings, the patients have clothing,—all of which may usually be disinfected or absolutely cleansed by boiling. The scope of boiling as a sterilizing, Pasteurizing or disinfecting agent is therefore very wide,

and it is something which is within the reach of all, while other methods may not be.

Steam. Steam heat answers much the same purpose, but is more convenient. A steaming apparatus, which will contain a hundred-fold more than any boiling apparatus, can be made and run at a very low cost. When sterilization is to be carried on day after day, it would be much cheaper in the end to have a steam sterilizer, for it would require less fuel and give much more space. It will not only answer the same purposes as boiling but will be accompanied by less risk. Milk sterilized by steam seems to be in a better condition than that subjected to boiling, for the steam heat is much more uniform and less likely to produce a change in the composition of the milk. Utensils may be handled with greater ease from a steaming vat than from boiling water, and so with other things which steam can thoroughly penetrate. In the laboratories nearly all moist sterilization is carried on by steam.

Steam Sterilizer. The apparatus used for this purpose is simple and not much different from the ordinary kitchen vegetable steamer. Conceive the kitchen vegetable steamer with its perforated bottom, its cover, and its low sides, extended till it stands from two to six feet high. Place in the center of the cover a hole for the escape of steam, because moving steam is more effectual than stagnant steam; then a steam sterilizer is complete. To make it as convenient as possible, there is a place in the cover for a thermometer and the bottom is fixed upon a suitable water vessel to which it is permanently fastened and which is usually a mere continuation of the walls, copper lined for the water and flared out to give an extensive heating surface. A glass tube connected with the water pot indicates the amount of water and a stop-cock drains off the water when desired. The upper part of this boiler-like arrangement is therefore used for a steam chamber and the lower portion, about one-sixth of the whole, is the water pot. Underneath the water pot the gas burner is placed. Wire baskets or tin receptacles are often employed for managing small articles with ease. Such a steamer or steam sterilizer is used in the laboratory; but the adjustments for con-

Fig. 12. Steam Sterilizer.

venience sake may be dispensed with when no degree of accuracy is demanded as in experimental work.

Autoclav. Mention has been made of the use of steam under pressure and of course at a higher degree. For this method of sterilization, a special sterilizer is necessary and is called an autoclav. This is of much the same pattern as the steam sterilizer just described, but instead of the steam escaping, the chamber is made steam tight so as to withstand several pounds pressure. At the top is a gauge to denote the pressure and a safety valve to provide against danger. The thermometer is present as in the other case. In this apparatus, the steam may be raised to 115° C. [239° F.] or 130° C. [266° F.] and one continuous heating will be equivalent to several discontinuous heatings in the ordinary steam sterilizer, thus saving much time. The activity of steam becomes far greater as the temperature passes above 100° C. [212° F.]. Owing to the saving of time from the greater activity of the steam at 130° C. [266° F.], this apparatus is much favored in some places for certain purposes.

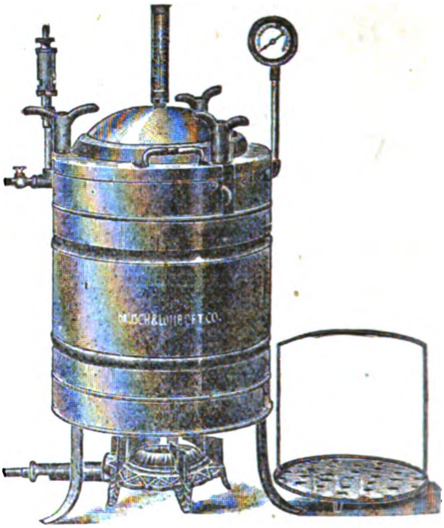

Fig. 13. Autoclav.

Moist heat is adapted to the sterilization of media or liquids which are prone to evaporate or undergo decomposition in the process of heating. The preserving of fruits and vegetables may be accomplished by this means and in canneries this agent is utilized in some manner. Anything that will stand boiling or steaming may be subjected to this method of sterilization without detriment and may be thoroughly sterilized if the boiling water or steam will penetrate the material.

I hesitate to consider the time required because it depends upon a great variety of conditions and it is impossible to include them all. Some time is always required to raise the substance under process of sterilization to the same temperature as steam. If there is a large bulk, much time is required; if only a small bulk, a few minutes will do. With this in mind, it *may be* safe to state that two or three minutes will kill all bacteria in the vegetative form. As an illustration of this, liquid in a tube three-fourths of an inch in diameter may be sterilized at 100° C. [212° F.] for fifteen minutes each day during three successive days—the fractional or discontinuous method. Heating once at 130° C. [266° F.] in the autoclav will accomplish the same thing. If this same liquid were placed in a can holding a quart, that quart of liquid would require at least an hour's heating each day for three successive days. The situation is now stated, and the conclusion can only be an exercise of the judgment in ascertaining how long it will take to raise the substance to the degree required. In this way sterilization by moist heat is conducted.

Dry heat. As was suggested at the beginning of this discussion on sterilization, each form has its advantages over the others.

Dry heat can be made very effectual by using a high degree, which for a short time will accomplish more than could be expected of steam. Instead of using the discontinuous heating plan, one sterilization will be sufficient. Dry heat is usually applied in two ways, the direct flame and the oven.

Flame. Wherever the flame may be utilized as an agent to kill bacteria, no more positive and satisfactory means could be offered. Its uses are, however, very limited. In the laboratory, the platinum needle which is used for inoculation is brought to a red heat and is thus sterilized. Old knives and scissors employed for post-mortem work are rendered free from life. This intimates the possible uses. On the farm old knives and instruments used in the cutting of animals dead from anthrax, blackleg, tuberculosis, or any infectious diseases are safe only after they have emerged from the purifying influence of the flame. In this connection, although it does not properly belong under this head, may well be added that the disposal of carcasses in which infection was present or suspected or in fact the disposal of any material which would be likely to convey danger is by far the best accomplished through the flame.

Hot air oven. In dry heat sterilization, the hot air oven has wide application and as a practical sterilizer is of great importance. It is a simple double walled oven, having an air space between the walls which opens near and about the flame; otherwise it closely resembles the oven of a gasoline stove. In the top are holes for the thermometer and thermo-regulator which regulates the supply of gas and heat. (This instrument will be described with the incubator.)

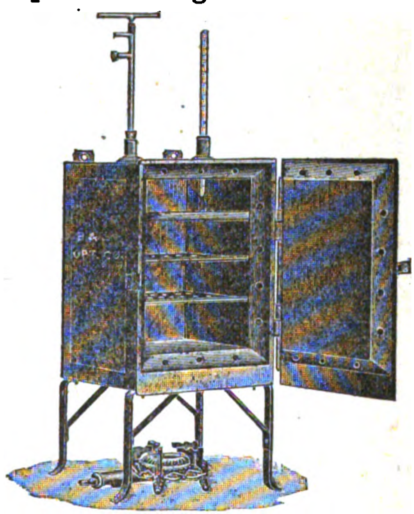

Fig. 14. Hot air oven.

The hot air oven is designed for the sterilization of glassware and other hard and dry materials not injured by an exposure to a high degree of dry heat. Clothing can be sterilized but with more difficulty than articles whose surfaces are exposed. Instruments may be made bacteriologically clean in this manner; attention must be given to the degree of heat, lest the temper which is of so much value in some instruments be destroyed.

It has been found that 128° C. [262° F.] will kill the vegetative forms and that 140° C. [284° F.] is required to destroy the spores; consequently it is customary to heat the oven to 150° C. [302 F.] for one hour to insure absolute sterilization.

Chemicals. Chemicals are mostly used as disinfectants, and are not regarded with much favor as sterilizers. There are several reasons for this. It would be absurd to sterilize or attempt to sterilize media with a chemical which acts as a germicide—germ killing—and which generally is actively poisonous. It would be substituting for bacteria a poison as detrimental as the bacteria themselves. Agents of this kind seldom kill outright, or within several hours, but rather retard develop-

ment, thus making chemical agents impracticable. They, nevertheless, have their use as sterilizers. It is possible to practically sterilize a surface of wood, as the floor, the table, etc., and they are fitted for cleansing walls and ceilings. Metallic surfaces may be purified, and surgical instruments rendered aseptic—free from bacteria producing diseased conditions. These chemicals may not kill the bacteria, but they do prevent their growth, which is a form of practical sterilization. A vessel may be sterilized with chemicals and the chemicals then washed out with sterilized water. Chemical sterilizers fit in where other means cannot be employed. The substances used for this purpose will be considered in another bulletin, which will follow later, taking up germicidal agents and disinfectants for farm use with practical application. Chemicals as absolute sterilizers are of very limited application.

Filtration. By this is not meant filtration by the ordinary filters of charcoal or sand, nor any improvised filter for temporary use. Such filters may be able to remove suspended particles of matter and assist in the oxidation of organic matter, but they will not remove bacteria.

Unglazed Porcelain. There is only one filter that will strain out the bacteria; this is moulded from a fine plastic substance, and is baked at a very high temperature. There is produced an unglazed porcelain. If perfect, the finest particles, not even bacteria, will pass through this filter, but the liquid will, when under pressure; without pressure it would pass through impracticably slowly. To apply pressure the porcelain is made in the forms of long tubes, which are placed in cylinders containing the material for filtration. The top is fitted closely to allow pressure upon the liquid in the cylinder; this pressure forces the liquid through the porcelain into the inner side of the tube, where it is perfectly free from organic particles or bacteria, as the case may be. All the suspended matter adheres to the outer surface, from which it is easily removed.

Filtration of this kind is resorted to in the study of products, formed by the action of bacteria. This filter is also used largely in the filtration of drinking water. For this purpose it is strongly recommended, provided the filters are without flaws. It has been highly praised where it has been used on a large scale in furnishing water to the inhabitants of villages. If India, where this work is in operation, were to make universal use of them, the mortality from Asiatic cholera would doubtless be reduced to a fraction of one per cent.

Cotton wool. For filtration of air in cultural work, ordinary cotton-wool is utilized. This will not free the air of bacteria if a very strong current is forced through. The bacteria apparently lodge in its meshes before reaching the media within. To illustrate what cotton-wool will do in arresting minute organisms, an early experiment with fermentation may be cited. In order to demonstrate the action of yeast plants upon sugar solutions, a tube was filled with a very weak solution of sugar, containing some nitrogenous matter. It was rendered free from bacteria and yeast plants and a sterilized piece of cotton-wool was inserted half way down the tube. The yeast plant was added to the upper half but the lower half was left uninoculated. The upper half fermented and the lower half remained unchanged, showing that the cotton-wool formed a perfect barrier to the yeast plant. It was in about 1854 that it was first used and now it is almost exclusively employed to close culture tubes against infection from the outside.

PREPARATION OF MEDIA.

Up to this point the requirements of bacteria have been given due consideration. The nature of their food has been discussed, and the elements constituting that food; it has also been stated that moisture is an essential feature of the food, and that a suitable reaction is necessary. These are the factors which must enter into the nourishment of bacteria. With these data it becomes possible for the laboratory worker to prepare a medium which will embrace these conditions; but besides the mere matter of a proper nourishment, the experimenter has learned that different species of bacteria produce different growths upon the various media or food stuffs, and this fact he utilizes in identifying bacteria; consequently, certain media have an advantage over other media. The investigator, therefore, strives to provide a medium which will not only answer the requirements of food but also those of a biological character.

Classes.

It is customary to divide media into two distinct classes, liquid and solid media. Each has its particular purpose in the laboratory. For the inoculation of animals, the study of bacterial products, and mere cultivation, liquid media are satisfactory. When animals are inoculated with bacteria, a syringe is employed which requires liquid media. In the study of bacterial products, a liquid substance is treated more easily. To transplant bacteria with the object of keeping them alive, liquid media, which is readily made, is suitable. While cultural properties are not so pronounced in liquid media, they however have their significance, and in some of these media as, for instance, milk, this feature is very valuable.

Liquid Media.

There are many liquid solutions which are especially adapted to the growth of bacteria. Milk has been mentioned. More generally used than milk and better fitted for ordinary work is bouillon. This is owing to its perfect clearness and freedom from sediment; at the same time it possesses nutrient material of the widest range. To make it, one pound of chopped lean meat is shaken in one quart of water and allowed to stand for twenty-four hours or steeped for one hour that the meat extracts and soluble salts may pass into solution. The insoluble albuminous portion of the meat is strained off and to the filtrate is added one per cent of peptones which are soluble and not coagulable by heat. These take the place of the meat that was strained off. One half per cent of ordinary salt is added to facilitate the solution of the peptones. When everything is dissolved a suitable reaction is obtained by the addition of some alkali, for the meat solution is usually acid. At this stage the mixture is heated, and boiled for one hour. It should then be clear and the sediment formed may be filtered off. It is now ready to pour into tubes of glass, called test tubes, which have been plugged with cotton-wool and sterilized in the hot air oven for one hour at 150° C. [302° F.]. Having filled these tubes to the depth of one and one-half inch with the bouillon, they with their contents are sterilized in steam heat for fifteen minutes each day for three successive days, as directed under sterilization. At the end of the third sterilization, the bouillon tubes are free from bacteria and are ready for the reception of any species.

Bouillon.

Milk.

Milk tubes are prepared much as bouillon. The milk is usually employed unmodified and poured into tubes which have been prepared in the same way as those used for bouillon. The steriliza-

tion differs, in that milk requires more time, because of the very resistant bacteria that may be present in it. The bouillon, it will be remembered, had undergone several heatings before pouring it into tubes. The milk on the other hand had been continuously exposed since it left the udder of the cow. One half hour each day for three successive days is necessary for its complete sterilization. Many other liquid media are made for the cultivation of bacteria, but most of them have special objects; for this reason they will not be given consideration.

Solid Media. Solid media have two distinct functions, that of yielding characteristic growths and that of isolating species, both of which will be reviewed later. To accomplish these purposes it is desirable that these solid media be transparent and that they will liquify and solidify under certain conditions. Gelatin and agar-agar satisfy the above requirements.

Gelatin. Gelatin is a substance obtained from animal tissues and is used extensively in household cookery. However the gelatin thus used does not answer for bacteriological work which calls for the best silver or gold leaf quality. When this substance is dissolved in water it gives a jelly-like mass; when hot it is liquid and when cold solid. Perfect transparency also exists. It will not be necessary to point out the difficulties to be met in the making of gelatin medium nor state with exactness the steps of the process; suffice it to say what constitutes gelatin medium. It is simply the bouillon with ten or twelve per cent of gelatin added and dissolved. When it has been made properly, it is transparent, solid when cold, and of a suitable reaction. This gelatin will liquify at 24° C. [75° F.]. Sterilization is accomplished the same as bouillon, fifteen minutes each day for three successive days.

Agar-agar. A dried sea weed has been called agar-agar. When placed in water it swells and gradually dissolves. In solution it forms a very hard jelly-like material. Without attempting to describe in detail the process of making, agar-agar may be substituted for gelatin. It yields a transparent medium which will liquify at 85° C. [193° F.] and solidify at 42° C. [108° F.]. This medium is especially adapted to the cultivation of bacteria needing an incubator temperature 37½° C. [98° F.], for which purpose gelatin would not answer. One half hour each day for three successive days is required in the sterilization of agar because of the slowness with which it liquifies.

Blood Serum. Besides gelatin and agar, blood serum is commonly used. This is the clear fluid rising from clotted blood and contains large amounts of albuminous material. That its transparency may be preserved, it is placed in tubes as the other media and sterilized at 60° C. [140° F.] for two hours each day for several days; when it is sterilized, it is subjected to a heat of 70° C. [166° F.] for the purpose of solidifying. It is usually inclined in the tubes to increase the surface and solidified at once. In this case the usual temperature could be employed to sterilize.

Potato. One other medium must be mentioned as a general cultural medium. It is the common Irish potato. This is boiled, cut in cylinders the size of the tubes, then diagonally cut from top to bottom in halves. By this operation a good surface is presented and each half is placed in a tube. The tubes are then sterilized fifteen minutes each day for three successive days.

All of these media, both liquid and solid, contain the necessary constituents for the development of bacteria. Each finds its use under different

circumstances and conditions, and yields a growth peculiar to itself which is studied closely in connection with the biological history of every species of bacteria. They all assist greatly in the diagnosis of species.

PLATINUM NEEDLE.

This instrument is of very common use in the laboratory. It consists of a glass rod in the end of which is fastened a platinum wire of medium size. Platinum is used because it will withstand any number of sterilizations in the flame without destruction. It is employed to inoculate tubes and to convey bacteria from one medium to another. Sometimes it has a loop at the end and sometimes is straight. It may be suited to whatever purpose desired.

HANGING DROP.

It is always very desirable to study a plant or animal in its natural condition. The form, the consistency of the protoplasm, spore formation and motility in the case of bacteria are all best observed as they appear in nature. The form may be studied carefully, with a view to decide the exact classification of the species, the manner of grouping, whether in threads or chains, or other groups, and any variation that may exist in the form. The consistency of the protoplasm evokes much interest in many species. Peculiarities prevail which require close and prolonged investigation, and often lead to results of a particularly practical nature. The spore-bearing bacteria may illustrate their methods of forming spores in their natural condition much better than when stained. All of these features are within the scope of a hanging drop.

Fig. 15. Hanging Drop.

Preparation. It is made by taking a very thin, flat piece of glass, called a cover glass or slip, and placing a drop of sterilized water in the center of it, about the size of a pin-head. Into this drop the bacteria which are under investigation are conveyed by the platinum needle. This cover slip is then placed over a hollow in a glass slide, the dimensions of which slide are one inch by three, and the thickness that of a window pane. The drop is turned downward when placed over the circular hollow, and still adheres to the cover slip. This done, the drop is virtually suspended in a glass cell, and to prevent evaporation a little vaseline is spread about the border of the hollow, thus making the cell air tight. It is now ready to study under the microscope.

MICROSCOPE.

The microscope used for the study of micro-organisms is compound and capable of enlarging the object about one thousand times. [It must not be thought for a moment that the more a microscope magnifies the better it is. The real value of a microscope is not determined in this way.] To enter into a discussion of the different parts of a compound microscope and its relation to the study of bacteria would be making a futile effort in this connection. The pur-

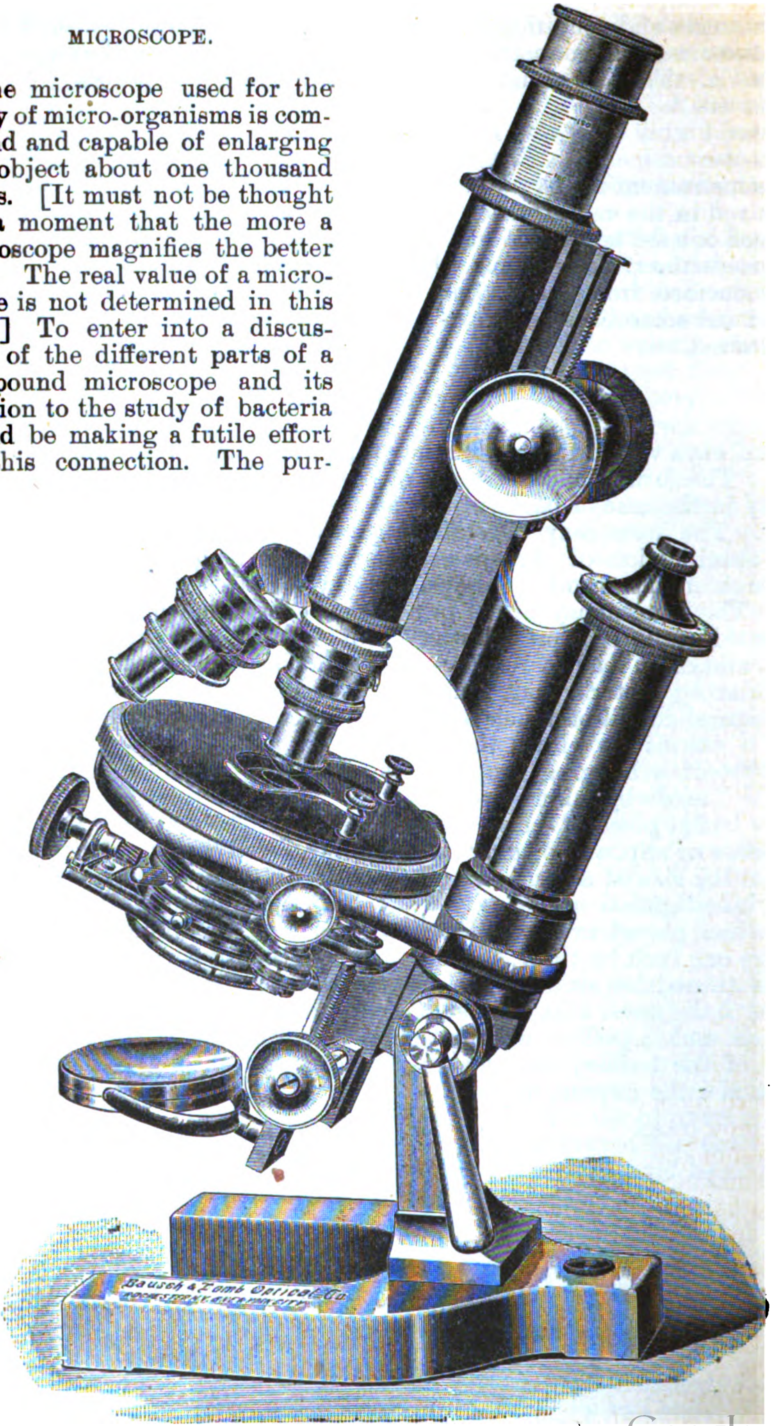

Fig. 16. Compound Microscope.

pose is to state one or two principles underlying it. A lens convex on both sides, or convex on one side and plane on the other will magnify objects. If the double convex lens be used to magnify an object, and another lens to magnify the image formed by the first lens, the object is magnified highly. In figures, if the first lens magnifies one hundred times and the second lens ten times, the image of the object seen through the first lens would be one hundred times as large. Now, if the second amplifies this image ten times, the object seen through both lenses would be increased one thousand times. In this way the ability to see very minute objects becomes possible. The lenses are mounted in a brass barrel, and this is attached to a steady stand. This is the simplest form of a compound microscope. It is through the microscope that the morphological properties of bacteria are made known, and this is the only means available.

STAINING BACTERIA.

In their ordinary conditions bacteria are translucent and many times are very difficult to see. To overcome this obstacle to the proper study of micro-organisms, stains have been called into requisition. They now form a very important part in the biological study of bacteria. The stains used are known as aniline stains, indirect products of coal tar. They correspond to the diamond dyes in commerce and many of them are the same. When desired for use they are dissolved in alcohol to saturation and this solution is diluted with water.

Method. A cover slip is evenly spread with a loopful of material and dried carefully over a flame. By this drying the bacteria are fixed on the cover slip and are thus prevented from washing off. The stain is then applied directly upon the prepared side of the cover slip by means of a pipette and allowed to remain about a minute, when the surplus stain is removed by water. The cover slip is now ready for examination under the microscope.

Special Methods. Besides this simple staining, methods more complex are employed for the recognition of certain bacteria, for the study of peculiarities, and for the satisfactory demonstration of spores and flagella. Some bacteria will respond to one method of staining while others will not, a fact which frequently allows one species to be distinguished from another. The tubercle bacillus is stained by a method to which only one or two others will respond readily. Inasmuch as these others are not likely to be met under the same circumstances as the tubercle bacillus, this method of staining becomes truly diagnostic. At other times there are peculiarities inherent in certain bacteria which can only be sharply illustrated by special stains. In the diphtheria bacillus are peculiarities of the protoplasm which require a distinct stain to determine them. Spores are questionable till they respond to a certain staining reaction. It consists in making a penetrating stain by the addition of carbolic acid. By this means, the spores as well as the vegetative cell may be stained. After the spores are once stained they part with the stain as reluctantly as they took it, but the color is easily removed from the vegetative form; consequently after the spore is stained the color is readily removed from the vegetative form leaving the spore colored and the vegetative form uncolored. An ordinary stain is now applied to the vegetative form which is a contrast to the color of the spore and which will not affect the color of the spore at all. This results in having the spore of one color, say red, and the vegetative form of another color, say blue. A strong contrast of colors therefore exists and the spores are seen distinctly. In the demonstration of

flagella, stains are essential. As in fabrics, substances are employed to fix the stain in the tissue. The flagella are first treated with this fixing solution called a mordant, then followed by an application of a strong staining solution.

INCUBATOR.

Attention has been called to the sensitiveness of some bacteria to a slight variation in temperature. The tubercle bacillus will not develop if the temperature varies over two degrees, and is susceptible to smaller changes. The best temperature at which it will grow is that of the body 37½° C. [98° F]. The same is true of many other infectious bacteria; the pathogenic bacteria as a rule require a suitable temperature. For many other purposes of a technical nature in a bacteriological laboratory, a constant temperature, a temperature that will not vary over the one-tenth of a degree, is required. To comply with these conditions an apparatus called an incubator has been devised especially for bacteriological work. The principle underlying it is much the same as an egg hatcher, but the egg hatcher bears about the same relation to the laboratory incubators that coal tongs do to watch makers' pincers or tweezers. The incubator has double copper walls between which is kept distilled water. Over the whole is placed a thick covering of felt. The doors are double and the outer one is also covered with felt. In the top is a place for a sensitive thermometer, a thermo-regulator and an escape for foul air within.

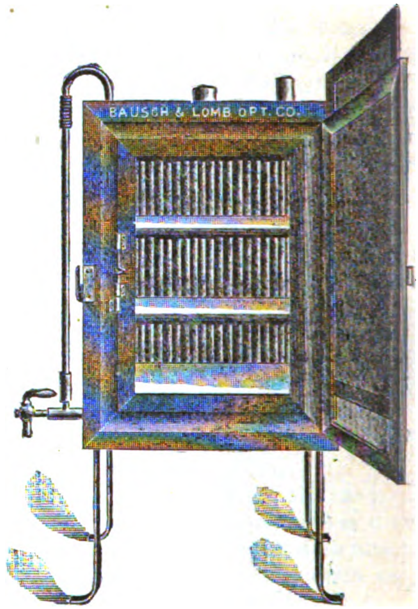

Fig. 17. Incubator.

Thermo-regulator. To regulate the amount of gas supplying the burner, a thermo-regulator has been made. It consists of a tube with arms, containing mercury. Through the arms the gas passes into the tube and out to the burner. There is another adjustment arm which regulates grossly the height of the mercury in the tube. When ready for use one arm is connected with the gas supply by a rubber tube and another with the burner. The tube with its mercury is inserted into the incubator. The mercury as in a thermometer, contracting with the cold and expanding with the heat, operates upon an opening through which the gas passes. When the mercury in the tube has been adjusted to 37½° C., this regulator will hold it constantly at that point. If the temperature of the incubator should fall the mercury in the tube would contract and increase the size of the hole through which the gas passes and thus increase the supply of gas to the flame; if the temperature should rise above

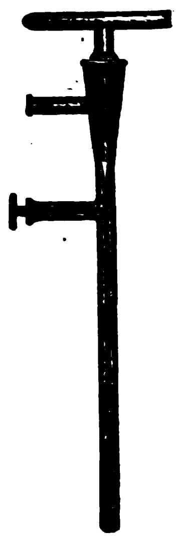
Fig. 18. Thermo-regulator.

$37\frac{1}{2}°$ C. the mercury would expand and decrease the size of the hole and thus decrease the supply of gas to the flame. In this way it is possible to hold a good incubator within a slight variation.

Safety burner. In connection with an incubator is supposed to be a safety burner. The ordinary gas burner could be used to obtain the heating results, but a small draught would blow it out and allow the gas to escape into the room. To prevent this escape of gas if blown out, a spring is attached near the flame; when it is hot it expands and holds up a lever which acts as a stop-cock for the gas; when it cools the spring contracts and the lever falls, shutting off the gas. In lighting the burner, the lever is held up with a catch, until the spring expands and holds it; as soon as the flame goes out the lever falls, when the spring cools and retracts.

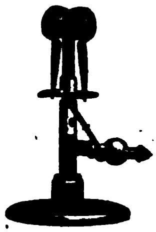

Fig. 19. Safety burner.

CULTIVATION OF BACTERIA.

To isolate and cultivate the various species of bacteria is the object at which we have been aiming from the very beginning of our discussion of laboratory methods. This is necessary for an investigation of their morphological and chemical natures. We are now ready for a systematic laboratory treatment.

The isolation of bacteria is the first step in their study. To do this, the material which is to be examined must always be guarded from outside contamination lest the results be vitiated. Assuming that it is ready, a bit of it is transferred to a liquefied gelatin tube and thoroughly stirred. We will call this tube No. 1. From No. 1, three loopfuls are taken and mixed with a liquefied gelatin tube No. 2; from No. 2, three loopfuls are taken and mixed with another liquefied gelatin tube, No. 3. The object of using three tubes is to dilute the bacterial solutions so that there will be but few bacteria in No. 3 tube. The reason for this will appear as we go on. The tops of these tubes are sterilized in the flame and the tubes put aside to cool. Three sterilized Petri dishes are gotten ready. These dishes are round, about five-eighths of an inch high, and four inches in diameter. The bottom fits directly into the cover as the bottom of a telescope fits into its cover, and thus precludes any contamination from outside. The contents of the cooled tubes are poured into these Petri dishes and spread over the surface of the bottom by the lip of the tube. The Petri dishes are marked Nos. 1, 2, and 3 to correspond with the tubes. This operation is called plating and its purpose is to separate the bacteria and scatter them over a large surface. Each micro-organism upon growing will give rise to a mass of its own kind, called a colony, which will appear upon the gelatin as minute whitish

Petri dishes.

Plating.

Colony.

Fig 20. Petri dish.

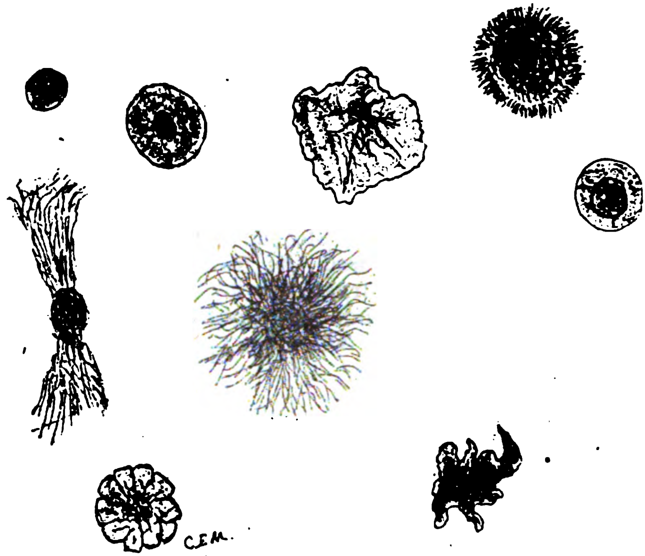

Fig. 21. Colonies.

Counting. spots—pin points. If we wish to count the number of micro-organisms present in one cubic centimeter of water, we would add this amount to a liquefied gelatin tube and make a plate of it as before, using however only one plate and making no dilutions at all. The plate would then be allowed to develop its colonies and these colonies would represent the number of micro-organisms present in the one cubic centimeter of water. If they are very thick we use a hand magnifying glass and place over the plate a piece of glass measured off into small squares. The numbers of colonies included in several squares are averaged. The area of the plate is then computed by the number of squares and multiplied by the average number of bacteria in each square. This will give the entire number of bacteria in the plate and in one cubic centimeter of water.

Fig. 22. Counting apparatus.

Cultures. If pure cultures of bacteria are desired the colonies are carefully studied and those presenting different appearances are taken for transplantation. Those having the same characteristics are supposed to have been produced by bacteria of the same species. To transplant, a colony is selected under the microscope and the straight platinum needle sterilized. The colony is watched through the microscope and the wire introduced into it without coming in contact with any other colonies, or with any apparatus, in fact with anything but the colony; for, if it is touched by anything else, it is useless for producing a pure culture. After the colony has been taken up on the end of the needle, it is introduced

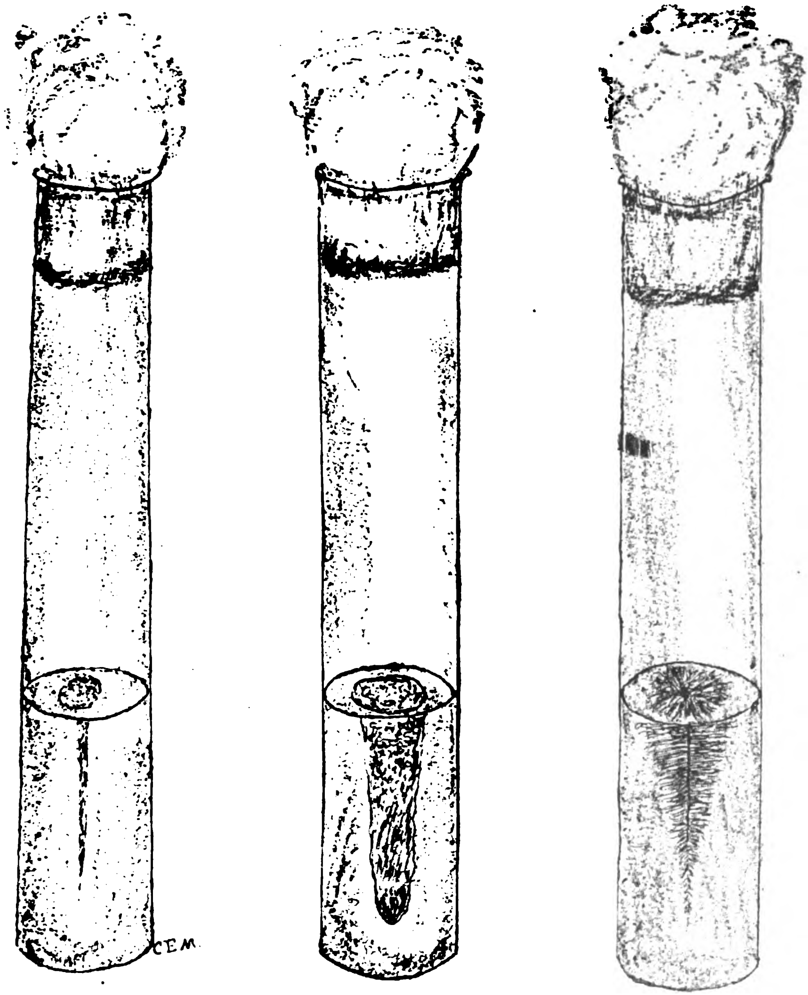

Fig. 23. Cultures in Gelatin.

into a solid gelatin tube, by pushing it from surface to bottom, or into any tube prepared for its reception. This is supposed to yield a pure culture of a distinct species. Each kind of colony is treated likewise, if it is

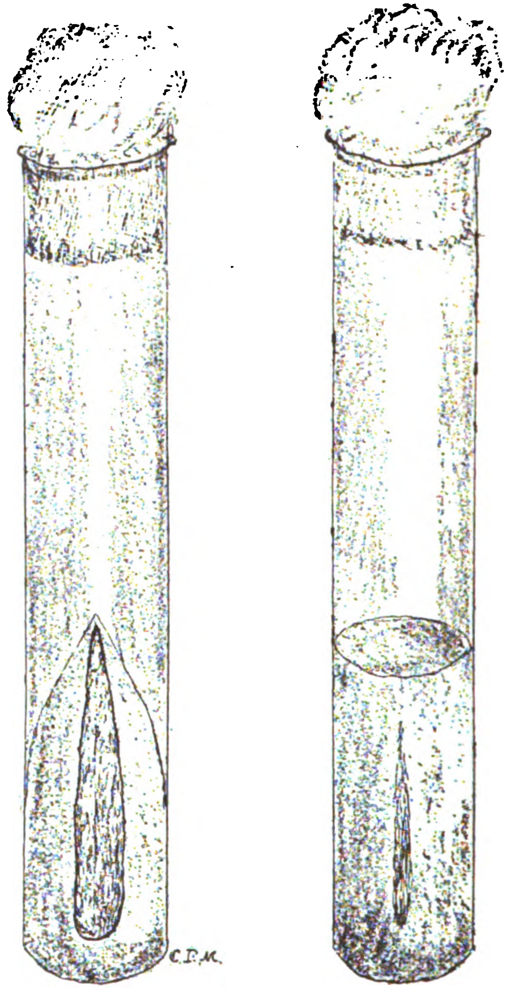

Fig. 24. Cultures in Agar-agar.

desired to study them all. Once in a pure culture we are able to transplant them in all kinds of media for the object of studying their different

growths and chemical relations, and may investigate their morphological properties under the microscope at will.

Anaërobic Cultivation.

Fig. 26. Anaërobic apparatus for tube culture. (Novy.)

What has been said about aërobic bacteria applies to anaërobic bacteria only in part. Everything is exactly the same with this exception: The plates and tubes when made are placed into a jar or bottle, made for this purpose, into which hydrogen or some other inert gas is passed as a substitute for air in which these bacteria will not grow.

Fig. 25. Anaërobic plating apparatus. (Novy.)

ANIMAL EXPERIMENTS.

The use of animals is limited almost entirely to work with infectious diseases. They become in this line of work an essential factor to successful experimentation, because of their power to similate man in pathological conditions. Without these animals it is doubtful whether the relation of the tubercle bacillus to tuberculosis would ever have been established; or the curative properties of antitoxin in cases of diphtheria; or the relief in hydrophobia; or, in short, a knowledge of the various infectious diseases as to prophylactic measures or curative treatment. It is true that many lives of lower animals have been sacrificed for the cause of science, but when we take into consideration the results, we would be very near-sighted if we did not say that it was justifiable. Scientists do not destroy life promiscuously, but with a purpose; and they possess the same dread to take life in the case of rats, guinea pigs, rabbits, and all the smaller animals as those zoophilists who condemn this experimental work while munching a piece of juicy steak.

Animals are also used in the diagnosis of diseases, in the determination of the presence of poisons, and in the study of avenues of infection. They are virtually indespensable to the scientific worker who is called upon to guard the public against danger from unseen sources. Without these lower animals a large portion of scientific work would be at a standstill.

I am indebted to Bausch & Lomb, of Rochester, N. Y., for the electrotypes used in the illustration of this bulletin.

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ROPINESS IN CREAM OR MILK.

C. E. MARSHALL.

When milk or cream may be drawn out in threads or strings, or when either presents a slimy appearance of a stringy formation, the term, ropy, stringy, or slimy has been given to this condition, designating thereby, a diseased state which prevails to some extent among dairies, factories, and wherever milk is handled. It is, by no means, a new disease; on the contrary, milk analysts have struggled with it for decades, but without positive results. It was not until the biological explanation of many chemical changes was instituted by Pasteur, in his experimental work upon milk, wine, and beer fermentations, and suggested by others previous to him, but not worked out, that such perplexing questions as milk ropiness as well as other milk fermentations could be regarded in a reasonable light. Pasteur was able to say that a certain yeast plant could produce ropiness of milk, yet he failed to comply with the later requisitions of bacteriology in establishing beyond a doubt the exact relation existing between that yeast plant and the milk. Lister was the first to separate a distinct species which would produce ropiness in milk. Since Lister's time many species have been isolated and identified as connected with this peculiar fermentation. Each kind has its particular action. While all may be classed as giving rise to ropy milk or cream, no two of them will produce this condition in just the same way, nor will the milk give exactly the same appearance. Sometimes it is due to the bacteria adhering together in a ropy mass, caused by the secretion of a gum-like substance by the individual bacteria. In this case a string of micro-organisms may be pulled out with the milk or cream, thus rendering their functions only in an indirect way. Such bacteria are not so likely to decompose the milk by the destruction of any element composing it. They, of course, feed upon some of the constituents of the milk, but a change is not likely to occur in the component parts. On the other hand, there are those bacteria acting directly upon the milk sugar in the production of slime or ropiness, consuming a part of that substance. Then there are those whose action is more complicated, involving the other constituents of the milk.

Very frequently in normal milk, that is, milk kept under the usual conditions, bacteria are found which, unaccompanied by other bacteria, will manufacture ropy milk. The other bacteria ordinarily gain the ascendency and perform their functions before the bacteria producing ropiness can manifest themselves. Should the latter gain the ascendency, ropiness would occur and the cases of ropy milk would be multiplied greatly.

Whenever ropiness does exist, it may generally with safety be attributed to foreign and transient bacteria, which gain access to the milk, perhaps accidentally. They sweep down upon a dairy unexpectedly and apparently without a cause; but if the soil, the water, and the air; the cans, the stables, and milk houses could be accurately examined, in fact all those things which surround and have to do with a dairy, the avenue by which they entered would be discovered.

Many countries have been witness to this disease. In Norway, they make use of this ropy milk in the preparation of a drink, called Tättemjolk. The people place the leaves of the butterwort in the milk and the fermentation follows. Bacteria which would give rise to the same condition have been found on these leaves. In Holland, Edam cheese is manufactured from slimy milk. Many cases have been reported from Switzerland and Austria. France and other countries have had their share of this disease. To gain the exact extent of this condition in the United States is impossible. When the information is voluntary and comes from individuals who have been afflicted, reliance can be given; but when the information is sought from dairymen or milk-men, they will evade the question lest it might work harm to them. A few voluntary contributions have been given. in "Hoard's Dairyman." These cover about two years and are simply representative of the extent of territory involved and time of occurence. Doubtless a very small fraction of one per cent is represented by these individuals. In most cases, these contributions are in the form of queries and have been reduced to the minimum by eliminating all that has no bearing upon the matter in hand. Whenever the feeding is introduced, it is allowed to remain because it is a common opinion that the feeding is the real cause of the trouble.

The first case was located at Trenton, N. J., and occurred in the summer of 1893, beginning about the middle of July and lasting till about the first of August. The pastures were dry and short during the time. That the individual might ascertain whether the trouble originated from the food or pasture, he tested both and tried each cow's milk by itself, but failed to find the cause.

In October, 1893, a dairyman in Illinois stated that he had been visited by the ropy milk plague, and that it had appeared for a day or a week at a time since the middle of July: At certain periods it was very noticeable, at other times it was hardly perceptible. The whey tank was cleaned and the whey scalded every day; when not scalded it would appear like soft soap upon dipping the next morning. The curd would not cook firmly when the milk was ropy; cheese made from it lacked in flavor and an unpleasant taste was also present, while the keeping qualities were not satisfactory.

A man living near Memphis, Tenn., and running a dairy of forty cows, wrote as follows: "In running my dairy of forty cows, I have been troubled the last week with my milk 'roping.' Please tell me the cause. The cows were changed from a pasture, where there was running water, to one of corn stalks and cotton stalks, where the water was a pond in the field. I am feeding cotton hulls, a chop of corn, oats, and oil meal mixed together. Milk would turn ropy in about twelve hours. I buy corn and oats from a feed store." This happened in January, 1894. Another case was reported from Chillicothe, Mo., in April, 1894, where the milk remained sweet. It was set in deep cans in ice water. A simple query came from Massachusetts, in September, 1894, stating that the trouble existed.

Without commenting upon these cases at this point, I will pass on to two cases which have come under my observation recently. The first case occurred on the farm of Mr. A, located not far from Lansing. He runs a milk-wagon and supplies milk to about three hundred patrons. Fourteen healthy looking cows furnish the milk. Up to the time of the trouble they had been pastured on a low piece of land adjacent to the Red Cedar river, a branch of the Grand. There were marshy places along the shore to which the cows had access and in which, from the appearance, they were in the habit of passing a portion of their time. Through the middle of the pasture was another marshy strip and a very small stream. The remainder of the pasture was good firm meadow land, and contained a large number of shade trees. At milking time the cows were driven through a long lane to the barn, in which they remained during the milking hour only.

This barn was located near the house, and the part in which the cows were milked was on the west side. One door communicated with the barnyard on the south and another with the backyard by passing through a small open shed. Along the west side were numerous windows. The east side came in contact with the main floor of the barn and a silo which had just been renovated and tarred. The floor of the stable was rough and only partly made of boards, being that part where the cows stood, and a dung sink; the remainder was covered with stones.

The milk-house where the milk was cooled in cans was a frame building about ten by twelve feet. It stood in the barnyard about four rods south of the stable. There was one door which opened to the north, but no windows. Matched lumber had been used to cover the inner walls and the ceiling. On the floor was a layer of sawdust about one foot deep which had been placed there the winter before. Back from the middle of the milk-house was a large wooden tank which was filled with water from a well two hundred feet deep and pumped by a windmill.

The barn floor and milk-house floor were occasionally covered over with a layer of lime to purify them.

As soon as the milk was taken from the cows it was strained into cans which were carried to the milk-house when the milking was over, and placed in the water tank to cool; during the cooling the milk was stirred. The milk was again strained after cooling and was then ready for distribution.

These were the surroundings and methods of management at the time the trouble appeared. It was the fifteenth of September when Mr. A first observed it, but it was noticed by three of his patrons on Friday the eleventh of September. No complaints were heard on Saturday, but on Sunday, the thirteenth, there was a universal cry of trouble.

Suspecting that his cows had eaten some plant which would produce this condition in the milk, Mr. A immediately turned his cows into a higher pasture of wheat stubble in which there was a young growth of clover, and awaited an abatement in the trouble. Monday passed but there was no check in the progress of the disease in the milk and his patrons were leaving him.

Tuesday morning a sample was brought to the bacteriological laboratory. This sample was not ropy at the time, but ropiness became apparent by the next morning. There seemed no doubt about the cause of it Tuesday morning; consequently a plan of extermination was laid out which will be considered a little later.

To positively establish the nature of the cause, milk which had been sterilized and freed from bacteria was inoculated with a small drop of the specimen. In twenty-four hours this milk which had been inoculated developed ropiness and was used in turn to inoculate another lot of sterilized milk, and this in twenty-four hours was decidedly ropy. There was no question about what we had to contend with and Mr. A was eager to begin active measures, for on Wednesday so many of his patrons had left him; and, feeling that it was not right to sell milk of this kind, he had stopped his milk wagon. This meant a pecuniary loss to him of one hundred and fifty dollars a month.

Three points of interest were now before us: The first was to eradicate the trouble; the second, isolate the micro-organism; and the third, to locate it.

Our attention was first directed to the cans. In order to render them free from danger, each can was filled with boiling water and covered up; from time to time it was emptied and refilled, until it had been virtually subjected to boiling water for one-half hour. After the cans had undergone this treatment, they were exposed to the direct rays of the sun for the rest of the day. The sawdust on the floor of the milk-house was cleaned out and clean gravel substituted. The walls and ceilings were then washed with a solution of corrosive sublimate made in the strength of one of sublimate to one thousand parts of water. Having done this, three or four pounds of sulphur were burned in the milk-house. The cooling tank was also washed with the corrosive sublimate solution. Nothing could be done to the barn but to sprinkle it with the corrosive sublimate solution and add a fresh supply of lime to the floor. Before milking, the cows udders were washed with the corrosive sublimate solution made in the strength of one to two thousand. The cows were however, finally removed to another barn, before the trouble disappeared.

In attempting to isolate the specific micro-organism, the tubes first inoculated to demonstrate the microbial origin of the cause, had for their purpose also, what appeared to be the most feasible method for isolation. By the production of culture after culture from the cream, it was thought that the "ropy" bacteria would increase in number to such an extent as to reduce the other bacteria present to the least possible number. After repeated cultivation in this manner for some time, plates were made and after they had developed, this micro-organism which turned out to be the specific cause, was very plentiful and there was no trouble in obtaining a pure culture.

Simultaneously with the eradication and isolation of the micro-organism, we tried to locate the source of the bacteria During the removal of the sawdust from the milk house, a bacteriologically clean dish containing normal milk, which was gotten from a neighbor who had no trouble of this kind, was exposed. At the same time, another dish of milk prepared as the first, was exposed in the barn. Neither of these specimens produced ropy cream. The udders of the cows and the hands of the milkers were then thoroughly washed with the corrosive sublimate solution made in the strength of one to two thousand. The milk from each cow was drawn into an individual fruit jar and a number was placed upon it corresponding to the cow from which the milk was drawn. In the preparation of the cans used for this purpose, the boiling method of sterilization was employed and the tops screwed on, with the usual rubber collar, immediately after sterilization. They were not opened until the milker was ready to draw

the milk into the jar. As soon as each was one-quarter full the top was replaced and the jar was taken to the house for cooling Not long after, they were brought to the laboratory where they were examined from time to time to ascertain whether ropiness was present. Eleven out of the fourteen jars developed ropiness, some sooner than others but most of them within forty-eight hours. To illustrate the care exercised by Mr. A in this experiment and what cleanliness in milking will do, we wish to state that these samples of milk did not sour within sixty hours after milking, exposed to the warm temperature of the laboratory. Not having succeeded in eliminating the "ropy" bacteria by this step, milk was taken directly from the udders of the three cows whose milk first showed signs of ropiness in the fruit jars. It is possible to draw milk from the udder of a cow under an absolutely sterile condition. For this purpose flasks are prepared in the following manner: A 50 cc. Erlenmeyer flask is thoroughly washed and dried. A silver coin milking tube is then fitted to a glass tube which reaches nearly to the bottom of the flask, the meeting of the milking tube and glass tube forming a joint at the neck of the flask, where the cotton wool plug which is used to close the mouth of the flask will cover the joint. A thin layer of cotton wool is then slipped over the milking tube, covering the cotton wool plug and projecting over the lip of the neck of the flask. This is bound down firmly with thread by running it in every direction over the cotton wool forming a network and binding or fastening it underneath the lip. A cap is made to cover the milking tube entirely, extending from the cotton wool plug in the neck of the flask to the tip of the milking tube and covering the tip completely. It is made so firmly that it may be slipped on and off with ease. This outfit was placed in the sterilizing oven for the usual time. When ready for use the teat of the cow is washed with a corrosive sublimate solution, the cap removed from the milking tube, the tube inserted into the milk duct, and as soon as removed the cap is replaced. By following this method, sterile milk may be obtained from a cow if some milk be removed at first from the teat to render the duct free from bacteria. In this instance very little milk was removed before the insertion of the milking tube; but at the end of ninety hours the milk was still sweet and free from ropiness.

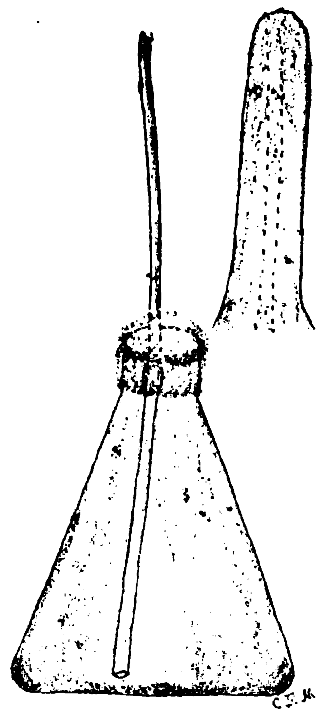
Fig. 1. Flask used in drawing milk

From the work thus far it would seem that the "ropy" bacteria were located on the udders of the cows; but before taking up the work farther concerning this matter, it is desirable to state the second case that came to our notice.

On Wednesday following the Tuesday when Mr. A brought a sample of his cream to the bacteriological laboratory, a milk dealer in the city of Lansing discovered ropiness in one of his cans. It was confined to this single can and did not spread to the others; all but this can were, however, peddled

out to his patrons. The milk that he handled came from various sources, for it was his practice to buy milk from the farmers in the vicinity of the city. The milk that this single can contained was secured from a farmer living three miles out of the city. A visit to his farm revealed the following facts: The cows were pasturing in a large meadow adjacent to the road and barnyard. Through the middle of this meadow ran a small stream, but that portion of the pasture bordering upon this stream was neither marshy nor very low. From the stream, the meadow had a gradual but pronounced rise and it would not be considered a low pasture land. There was no stagnant water about and the cows usually drank the water provided at the well, yet sometimes refreshed themselves at this small running stream. The milking was done in the open air and in cleanly surroundings. There was no special means of cooling the milk and so far as could be ascertained, it was not cooled at all. It was taken from the cows, placed in a can and carted to the city by the milkman. The farmer had no ropiness at any time so far as he knew, and had not noticed it on this occasion in the milk he reserved. This can which turned out to be ropy was taken to the home of the milkman and placed in his cellar, where the top was removed and the contents exposed the same as several other cans which he had at the same time, and in which ropiness did not develop.

It was about one week after this had occurred that a sample of the cream from the can in question was obtained. The milkman had preserved it. Upon a bacteriological examination by means of plates, the micro-organism producing the trouble was isolated and it proved to be identical with the one which caused ropiness in the milk of Mr. A. Its biological history corresponds precisely with that micro-organism which manifested itself on Mr. A's farm four and one-half miles away.

It was readily inferred that there must have been some means of communication. Close questioning could establish no possible clue, for they all claimed to have had no interchange of cans or milk within a month or two of this time. Failing in this, I turned my attention to the water found in the pastures of both farms, although the streams were not the same, both however flowing into the Grand river. A close bacteriological examination was made in each case but without any positive results. Another investigation was made of the air of the milk-house, barnyard and stable and this too failed to reveal the source of this micro-organism. Plates were exposed under the udders of the cows while milking and these added nothing to our knowledge.

The infection had about disappeared when the last investigations were made. Owing to their negative nature, we were forced to the conclusion from our first work when the trouble was at its height, that the infection came through the cows and that the bacteria were adherent to the udder. This was demonstrated almost beyond a doubt by the can or pint jar experiment and the flask experiment where the milk was drawn directly from the udders. How these bacteria happened to locate there and whence they came are still unsolved problems. What avenue of communication existed between the two farms and what they have in common are yet unknown. This class of bacteria may be found in the air, water or soil, but at present it is not determined in which this one may live.

CLIMATIC CONDITIONS.

With the data now given, the climatic conditions may be profitably considered. In all of the cases in the northern states reviewed at the begin-

ning and the two cases studied in the body of the work, the time of occurrence was between the middle of July and October; wherever ropy milk has prevailed, there is generally accompanying it a condition of the atmosphere which is peculiarly significant. No season of the year is better suited to the rapid development of bacteria than the time mentioned. The air is more or less saturated with moisture, and the temperature is high. This is the period of "dog days," and the air is muggy and oppressive; it does not differ much from the condition of the atmosphere just at the beginning of a thunder storm. Associated with this season is the phenomenally rapid souring of milk, and the large amount of decomposition in process. Algae are abundant in stagnant pools, and water everywhere seems to be teeming with life. It is almost impossible to preserve anything in a fresh state. As soon as the cool October weather creeps over our northern states, the conditions which favored the development of bacterial life have been changed, and the ropiness of milk or cream disappears with them; yet it is possible to have stringy milk in the winter season. Such cases would necessarily be rare, inasmuch as the temperature is so low as to retard their growth, and thus prevent any chance of their manifestation. In the south, where they are often visited with the trouble, even in the winter, the conditions are much different. There they may have the best opportunities for bacterial growth during the winter months. Bacteria, like the higher plants, have their season of greatest activity, and must be especially guarded against at this time, if trouble is to be avoided. They are more likely to be prolific and bold, for whatever they enter has a suitable temperature and moisture to aid them in their multiplication. The water is warm in the streams and lowlands, the soil is fit for their reception, and as soon as they find a vehicle of conveyance they travel from place to place. If they establish themselves in a dairy, barn, pasture, or house, there they will ply their depredations with vigor while the moist and hot summer weather lasts, and can be eradicated only by persistent efforts.

TREATMENT.

In the treatment of a bacterial devastation of this kind, many things which are now common to readers can be emphasized only. Since bacteria may find their way into the milk from the air, the lower portion of the cow, the milker, or the cans, the plan of extermination may be arranged accordingly. Although the air does have bacteria which may be detrimental to milk, yet it cannot be regarded as the most important factor. Since it may be a source, it must always be considered when the bacteria are to be eradicated, by ascertaining whether it makes any difference to change the cows to another barn or to milk them in the open air. Take the milk from the milk-house or pantry for a short time to see whether the trouble will disappear. By changing the air conditions and evironments, it may be possible to stop the evil at the start. If the air of the milk-house should be the carrier of the bacteria, it may probably be traced to dust arising from the floor or elsewhere, and would point to a thorough cleansing of the place. This can be done by first removing any dirt that may be about and then following with strong disinfectants. Wash the floor, walls, and ceiling with a solution of corrosive sublimate made in the strength of one part of corrosive sublimate to one thousand parts of water. Use this freely on all the woodwork, shelves, tables, and wherever it will not come in contact with metallic substances or utensils used in the dairy.

After this has been done, burn three or four pounds of sulphur to every one thousand cubic feet of air space. This may be done most effectually by closing all possibilities of escape and placing the sulphur in an iron vessel which rests upon bricks in a tub of water. To start it add a little alcohol. Allow the process of fumigation to continue from forty-eight to seventy-two hours. Any room or building may be rendered fit for use in this way. If it were a stable, a thorough scrubbing of walls, ceiling, and floor, with a few days of airing, would be all that could be done. Whenever whitewash can be used after the washing, it makes a good accessory.

To cleanse the lower portion of the cow, it would be well to clean off the thickest of the dirt in a dry state, then wash off with a solution of corrosive sublimate made in the strength of one to two thousand of water. Allow this to dry sufficiently to insure against any of the liquid dropping into the milk. The udders gather bacteria from the soil of the pasture, weeds, straw, water in which the cows may stand and from the soiled condition of many stables. Doubtless most of the bacteria which find their way into the milk enter by way of the udder. In the eradication of bacteria, the udders must be washed thoroughly among the first steps taken.

The hands and clothes of the milker have their significance, but unless infectious diseases are about, there is little chance from regular inoculation with bacteria of a detrimental nature. It is best, however, to have the milker wash his hands in a solution of corrosive sublimate made in the strength of one to one thousand, when there is trouble of a bacterial nature.

There is nothing so essential as a thorough cleaning of the milk pails and cans. When once harboring the bacteria, unless they are made absolutely clean, they will be a continuous agent of inoculation. Milk vessels should always be boiled for one-half hour after every milking when ropy milk exists in the dairy, and this should be followed during the presence of the trouble, for as long as it exists, the vessels will be contaminated and of course these injurious bacteria must be killed.

If it is impracticable to place the cans and milk pails in a boiler, boiling water could be utilized by filling the can with it and keeping it hot by a renewal every few minutes. This process of sterilizing should continue for at least one-half hour.

THE BACILLUS CAUSING THE TROUBLE.

Morphology: The length of this bacillus averages about two micromillemeters and the thickness is one and one-fourth—a very short thick bacillus. It is usually arranged in pairs and may be either single or grow

into threads of four, five or six. The ends are round and the protoplasm homogeneous in all of its stages of development. When forming in threads, it is impossible to distinguish the individual bacilli; they frequently resemble a single long bacillus.

Fig. 2. Bacilli of ropy cream.

Colony: The first appearance of the colony is round with a well defined and even border, having a blackish brown color and finely granular contents. Upon studying the plate, the largest number of colonies will present this aspect. There is no liquefaction which causes the colony to sink into the gelatin, but the surface colonies rest on and rise above it. Continuing to develop, the colony sends out from its border a thin and light colored plaque with a border not so well defined and somewhat uneven, simply a thin layer of micro-organisms spreading from the main body of the colony over the surface of the gelatin Again from this thin layer, as the colony grows older, another layer starts thinner than the one from which it proceeds and is almost void of color, translucent. The border is still less regular and almost ragged; sometimes it has a scalloped appearance. To the naked eye, the colony glistens and gives a rounded oval surface. Upon the application of the platinum needle, the colony will often adhere as a whole; at other times a ropy mass of bacteria will be drawn out. From this will be inferred the tenacious secretion of this bacillus.

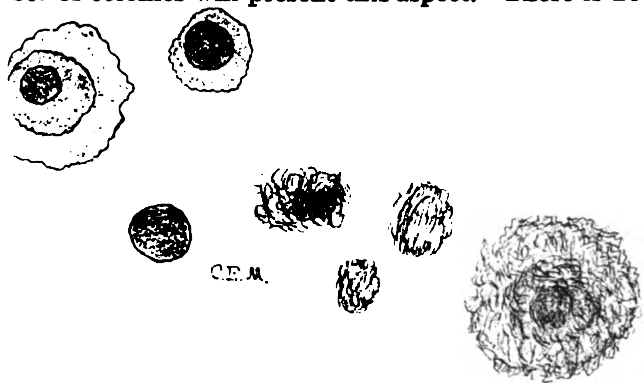

Fig. 3. Colonies of ropy cream bacillus.

After cultivating this bacillus for some time and plating it in the same gelatin, it was found that the colony had undergone a marked transformation, and in this state gave a loose patch work in its younger stage and a very irregular colony as it matured.

Gelatin Stick Culture: There is a slight growth along the line of inoculation, in some tubes simply a beaded development, in others quite a

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continuous growth appears, but it is confined to the puncture. On the surface, a moist glistening white mass is seen about the point where the needle entered the gelatin. The borders are somewhat irregular. The extent of the growth is limited to a very small surface and resembles a large colony which is not inclined to spread. In holding it to the light, an iridescent hue is revealed.

Agar Streak Culture: Along the entire streak and extending but a very short distance from the streak, is a whitish slimy and glistening growth with a scalloped border. The development is very rapid.

Potato Streak Culture: On the surface of the potato, it produces a yellowish white, creamy growth which rises above the surface and is confined to that portion inoculated, with no tendency to spread.

Bouillon Culture: At first the bouillon becomes cloudy and eventually a scum forms over the top. When the needle is applied to this it is possible to draw out a string several feet long and so fine that it is virtually invisible. As the culture becomes older, these bacteria form a jelly like mass in the bouillon and the bouillon itself responds as jelly. It is a difficult task to break up this mass by the addition of more liquid.

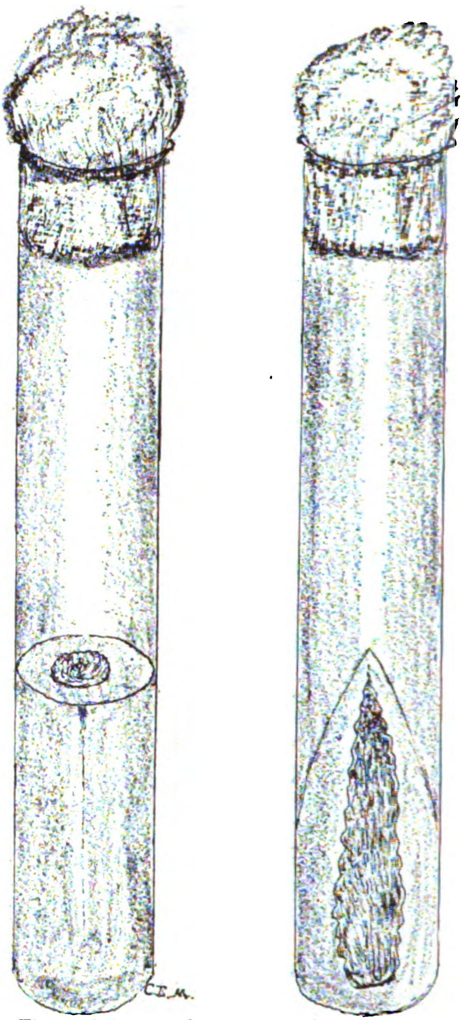

Fig. 4. Gelatin and agar tube cultures of ropy cream bacillus.

Milk Culture: When bacteria produce any peculiar condition of the milk, as the formation of lactic acid, butyric acid and other products, the investigator attempts to determine that constituent of the milk from which any one of these products is formed. In the lactic acid fermentation, the sugar of milk will gradually disappear until a certain per cent of acid is formed. Inasmuch as stringy milk may be produced from the sugar of milk or some of the protied substances, as caseine, it therefore becomes an interesting feature of the life history of this class of microorganisms to study their action upon the various component parts of milk. Although the cultured properties of the bacillus in question indicate whence comes this ropiness and preclude any further analysis, to settle the matter definitely an estimation was made of some of the substances constituting milk. This was carried out as follows: Flasks of milk were sterilized after the usual method, and were inoculated with the bacillus.

They were put away for three weeks, at the end of which time no apparent change had taken place, but ropiness existed. The caseine was then precipitated and found to equal the usual per cent, estimated in connection with the coagulated albumen. The amount of sugar was also ascertained to be normal. Judging from this work, the bacteria evidently feed upon the milk without producing any preceptible change, unless the change is so slow that a much longer time would be required.

The acidity was studied by taking two lots of the same milk which had been sterilized and treated together, and adding to one the bacillus and keeping the other as a control. The examination showed that the amount of acidity was not increased but very slightly decreased. Several repetitions gave the same results. In connection with this, work upon a number of slightly acid bouillon cultures demonstrated that the acidity was reduced. So far as it was possible to test it, the secretion of the bacilli was alkaline, but this is not positive since it is quite possible that foreign material might have been present to influence the reaction. No odors were perceptible in any of the media. This fact is quite significant in the study of any decomposition.

Butter: The work in connection with the butter I owe to Mr. G. H. True of this station. Separator cream was employed in two lots of equal amounts. In one, the bacillus was introduced in large quantities; in the other, the bacillus in the same quantities was not introduced until it had been Pasteurized at 70° C. for twenty minutes. Both lots were then placed away and allowed to ripen for twenty-four hours, when they were churned.

The loss of fat in the butter-milk was 2.2% in the case of the un-Pasteurized cream and 2.8% in that of the Pasteurized cream. The acidity of the Pasteurized cream was .27% and of the un-Pasteurized .57%. The time required to churn the Pasteurized cream was seventeen minutes and the un-Pasteurized cream twenty-seven minutes.

It will be seen that considerable butter-fat was lost. This was doubtless due to the holding of the fat globules in the adhesive secretion of the bacteria, for if the fat globules are once embedded in this material, it is extremely difficult to liberate them. The difference in the acidity is doubtless due to the fact that where the cream was Pasteurized, most of the lactic acid bacteria were destroyed, consequently the conditions usually present and favorable for the growth of lactic acid bacteria were changed. In the un-Pasteurized cream this class of bacteria performed its usual function. The difference in the time of churning is very noticeable. It is either due to the Pasteurization of the milk or to the action of the bacteria of ropy milk upon that substance which holds the fat globules. There is nothing, however, in the biological history of this bacillus which would indicate any such peptonizing action, yet I am not ready to say that it does not exert some influence upon the cream.

The flavor of the butter was not improved in the case of the un-Pasteurized cream and when it was Pasteurized, the butter produced was insipid to the taste. No peculiar aroma was present.

Temperature: This bacillus grows best at about 30° C. It is killed at 60° C. for twenty minutes. Freezing it for three hours has no influence whatever upon its vitality, and when it is transplanted, the development is as rapid as though it had been cultivated under the most favorable circumstances.

Motion: No real motion can be discerned; a slight Brownian motion is perceptible.

Stain Reaction: Responds very readily to simple aniline stains.

Spores: No spores could be detected.

At the time of going to print I find that this bacillus has lost under artificial culture a large part of its power to produce ropiness; it has also decreased in vitality, and in rapidity of growth—it now grows slowly and less exuberantly.

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HERBERT W. MUMFORD,
Agricultural College, Mich.

BULLETIN 141 FEBRUARY, 1897

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

FARM DEPARTMENT

FORAGE CROPS AND WHEAT

AGRICULTURAL COLLEGE, MICH.
1897

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BY A. A. CROZIER
ASSISTANT AGRICULTURIST

AGRICULTURAL COLLEGE, MICH.
1897

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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Grayling, Crawford County, 80 acres deeded.
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BULLETIN 142. **MARCH, 1897.**

SMALL FRUIT TRIALS AT THE COLLEGE.

BY L. R. TAFT AND H. P. GLADDEN.

STRAWBERRIES.

The soil where the strawberries have been grown is not suitable for the best results. In some portions too much clay is found; other parts of the field have a quicksand bottom, but a short distance from the surface. Heavy applications of stable manure have been given and every effort made by frequent and thorough cultivation to get the land in as good tilth as possible. The past season has been favorable for both plant and fruit production, and as the spring setting was made on a plot of ground much better adapted to strawberries than the setting of 1895, more uniform results are looked for in the season of 1897.

As a rule, the yield of the perfect flowering varieties was very small. Although they blossomed profusely, few fruits developed. From the fact that the imperfect flowered varieties bore full crops, it seems probable that the plants were too much weakened by excessive pollen production to develop the fruit, rather than that there was any lack of potency in the pollen.

TABLE No. 1.—STRAWBERRIES.

ABBREVIATIONS.

Sex.	Form.	Size.	Color.	
p, pistillate or imperfect.	b, broad.	s, small.	b, bright.	l, light.
b, bisexual or perfect.	c, conical.	m, medium.	c, crimson.	r, red.
	d, depressed.	l, large.	d, dark.	s, scarlet.
	i, irregular.			

Variety.	Sex.	Vigor (1-10).	Date bloom.	Date first ripe fruits.	Date last picking.	Productiveness scale (1-10).	Size.	Form.	Color.	Quality.	Firmness.
Acem	b	9.8	May 7	May 26	June 15	6 5	s	r c	l s	9	7.5
Afton	p	9	" 7	" 29	" 15	9.5	m to l	l c	d c	9	8.8
Allen No. 1	p	8.5	" 11	" 26	" 17	5.0	m	r c	b c	9	8.5
" " 3	b	9	" 13	June 3	" 15	7.0	l	r c	b c	9	8.5
" " 6	p	9	" 11	May 29	" 15	5.5	s to m	b c	l c	8.5	8
Apache	b	7	" 7	" 28	" 15	7.0	m	l c	l s	5	8.5
Aroma	b	8	" 13	June 1	" 20	9.0	l	l c	l s	8 0	9.5
Beauty	b	6	" 7	May 29	" 15	8.5	l	r b c	b d s	8.5	8
Beder Wood	b	8	" 7	" 26	" 17	8.5	m	r d c	l s	8.0	8.5
Belle	b	7	" 7	June 1	" 17	9	m to l	l c	b s	8.0	9.0
Belle of La Crosse	p	8	" 7	May 29	" 17	8.5	l	r b c	b d s	8	8
Belt (Wm)	b	8	" 7	" 30	" 19	9	l	l c	l c	8.5	9
Bessie	p	7	" 11	" 26	" 17	8	m	l c	l c	8.5	9
Bird	p	8.5	" 7	" 29	" 19	8.8	l	l c	b d s	9	9 2
Bixler	b	10	" 11	" 29	" 15	7.5	m	r d c	l s	9.5	8.5
Bomba	b	7	" 7	" 26	" 15	7	m	c	d c	9	8.5
Bowman	b	7	" 7	" 26	" 17	7.5	m	r c	l c	8	8.5
Brandywine	b	8.5	" 11	" 29	" 19	8	l	r c	b d c	9.5	8.5
Brooke	p	7.5	" 12	June 1	" 15	8.5	l	b d c	d c	9.5	8.5
Brunette	p	5	" 12	" 1	" 15	6	m	r c	d c	9.5	8.5
Bryant	b	9	" 12	" 1	" 23	9	l	s d c	v d c	8.8	9.8
Bubach	p	8.8	" 14	May 29	" 15	8	l	d c	l c	9	8
Cameron No. 2	b	8.5	" 7	" 26	" 15	8	l	l c	b c	9	9
Carrie	p	8	" 7	" 29	" 15	9	m to l	l c	d c	8.5	8.5
Charlie	p	9	" 7	" 29	" 19	8.5	m	l c	b d s	9	8
Childs	b	9	" 6	" 26	" 19	8	l	d c	b c	9.5	9
Clark	b	7	" 12	" 26	" 15	7.5	l	r c i	d c	9	9
Clyde	b	9	" 7	" 26	" 21	9.8	l	r c	l c	8.5	9.2
Columbian	b	7	" 11	" 29	" 15	7.5	l	r c	l s	8.5	8.5
Crawford	b	9	" 11	" 29	" 21	9	l	r c	l c	9	8.5
Crescent	p	8	" 7	" 26	" 17	8.5	m	r d c	l c	8	9
Cyclone	b	10	" 6	" 26	" 19	8.5	m	l c	d c	9	9
Dan Bisel	b	9	" 7	" 26	" 17	9	m	l b c	b c	9	9
Earliest	b	9	" 6	" 19	" 4	7	m to l	r c	l s	7.5	7
Early Jack	b	9.5	" 6	" 23	" 17	7.5	s to m	i	b s	7	7
Edith	p	8	" 15	June 3	" 19	8.5	m	l b c	d c	9	9
Edward Favorite	b	7	" 11	" 1	" 21	8.5	l	r c	b d c	9.4	9
Engle No. 1	b	7.5	" 12	" 7	" 23	8.5	l	r c	l c	8	9
Enhance	b	10	" 11	" 2	" 19	8.5	l	b c	l c	8	9
Enormous	p	9.5	" 13	May 29	" 19	9.2	v l	r c	v b s	9	8.5
Epping	p	9.8	" 11	" 29	" 19	8.5	l	r d c	l s	8	9
Feicht No. 2	b	9	" 11	" 26	" 15	8	m	r c	l c	8	8.5
" " 3	p	10	" 11	June 1	" 21	8.5	l	i c	l c	8.8	8
Fred Stahelin	p	9.5	" 7	May 26	" 19	9.0	l	i c	v d c	9.5	8
Gandy	b	8.5	" 14	June 1	" 25	8	l	b c	l c	8.5	8.5
Gen. Putnam	p	9 8	" 7	May 29	" 15	8	l	b c	d c	8.5	8
Graham	b	8.5	" 11	" 29	" 15	8.8	m	r c	d c	7.5	9
Great Pacific	b	10	" 6	" 26	" 15	8.5	l	r c	l c	8.5	8
Greenville	p	9.8	" 11	" 29	" 19	9	l	r d c	b c	8.5	7.5
Haverland	p	9	" 7	" 26	" 21	8.5	m	l c	s	8.5	8.5
Holland	p	5	" 11	June 3	" 15	6.5	m	l b c	d c	9	9
Hull's No. 3	b	8	" 13	" 1	" 23	7.5	l	s d c	l s	9	8
Huntsman	b	8	" 11	" 1	" 17	8	m	r c	l c	8	8.5
Iowa Beauty	b	8	" 11	May 29	" 17	7.5	m	r c	d c	9.5	8.5
Jarbalo	p	8	" 7	" 26	" 15	8	m to l	r c	d c	7.5	8.5

TABLE NO. 1.—STRAWBERRIES.—CONTINUED.

Variety.	Sex.	Vigor (1-10).	Date bloom.	Date first ripe fruits.	Date last picking.	Productiveness scale (1-10).	Size.	Form.	Color.	Quality.	Firmness.
Jay Gould	p	7.5	May 11	May 29	June 15	8	m	r c	b c	9.2	9.
Jones	b	8	" 7	" 26	" 15	9	l	d c	d c	9	8.5
Judsonia	b	8.5	" 12	" 29	" 15	8	l	r b c	l c	7.5	7
Kansas Prolific	b	8.5	" 7	" 26	" 15	8.8	m	r c	d c	9.5	8.5
Kentucky	b	7	" 11	June 1	" 25	7.5	m to l	r d c	l s	8.5	8.5
Klickita	p	9	" 11	May 26	" 21	7.5	l	r d c	d s	9	7.5
Kossuth	b	9.4	" 13	June 1	" 19	8.5	l	r b c	d c	9.2	9
Kyle No. 1	b	9.5	" 13	May 29	" 19	8.0	m	r c	l s	6	6
Leroy	p	9	" 7	" 26	" 21	9.2	l	d c	d c	9	9
Lida	p	5	" 7	" 29	" 15	8.5	l	r c	d c	9	8.5
Lincoln	p	8	" 11	" 29	" 21	9	m to l	r c	l c	8	8.5
Longfield	p	10	" 7	" 29	" 19	9.5	l	r c	d c	9.2	9.4
Long John	b	8	" 7	" 29	" 19	8.5	l	v l c	b c	9	8.5
Lovett	b	8.5	" 12	" 29	" 21	8.5	m	r c	b c	8	9.
Luther	b	6	" 11	" 26	" 15	8.5	s to m	l c	b s	9.5	8.4
Marshall	b	9	" 12	June 1	" 23	8.5	l	r c	d c	8.5	9.
Mary	p	7.5	" 16	" 5	" 23	8	l	b d c	b c	7	9
Maxwell	pb	9	" 13	" 1	" 21	8.5	m	r c	d c	9.8	9.5
Meek	b	8	" 12	May 29	" 15	8	m	r c	l c	8.5	8.8
Meridian	p	7	" 11	" 29	" 17	8.8	l	r c	d c	7.5	8.
Middlefield	p	9	" 12	" 29	" 21	8.5	m	r c	l c	8.5	8.5
Miner	b	8.5	" 11	" 29	" 19	8.	l	c	d s	8	7.5
Mrs. Cleveland	p	9	" 12	" 26	" 17	8.5	m	r b c	b s	8	8
No. 4 (J. S)	p	9	" 12	" 29	" 15	8	l	r c	l c	8	8.5
No. 6 (J. S.)	p	8.5	" 12	June 3	" 25	9	l	r c	d c	9.8	9
No. 16 (S. & B.)	b	8	" 7	May 29	" 15	8	l c	r c	d s	8	8.5
No Name	b	10	" 13	" 26	" 17	8	l	b c	d c	9	9
Ona	p	9	" 12	" 29	" 15	8.5	m to l	s r c	b d s	9.8	8.5
Orono	p	9.2	" 3	June 3	" 19	7	l	r c	v d c	8.5	9.
Oscar	b	8.8	" 13	" 2	" 19	7	l	r c	v d c	9.	9.5
Ostego	p	9	" 12	May 29	" 21	7	m to l	r d c	l s	8	8
Paris King	b	5	" 11	" 29	" 17	6	l	c	d s	8.5	8.5
Parker Earle	b	8.5	" 11	June 3	" 25	9	m	l c	d s	8.	9
Phillip	b	10	" 12	May 28	" 19	8	l	r c	d c	7.	7
Princeton Chief	p	9.8	" 13	June 3	" 19	8	l	l c	d c	8.5	8.8
Princess	p	8.5	" 12	" 1	" 17	8	m	r	c	9	8.5
Richmond	b	7.5	" 11	" 1	" 19	8.5	l	b c	d c	9.5	8.5
Rio	b	9	" 13	May 26	" 15	7.5	m	l c	b s	9	7.5
Robinson	b	9	" 7	" 29	" 19	9	m	r c	b c	6	6
Roser No. 1	b	9.8	" 6	" 26	" 19	8	m	r c	d c	8	8 5
Sadie	p	9	" 6	" 24	" 15	9	m	r c	d c	9	8
Sandoval	b	6	" 12	" 29	" 19	8.5	l	r d c	v d c	8 5	9
Seedling B	b	9	" 13	" 29	" 21	8.5	l	r c	s	7.5	7
Shawnee	p	7	" 12	June 3	" 17	8.5	m	l c	d c	8.5	8
Sherman	p	7	" 6	May 28	" 15	9.5	l	r c	d c	8.5	9
Shuckless	b	8	" 13	" 29	" 23	8.5	l	r c	d c	7	7
Smalley	p	8	" 7	" 29	" 21	9.4	m to l	r c	d c	7.5	9.8
Snowball	b	9.5	" 7	" 26	" 23	9	l	l c	b s	8	9
Splendid	b	9	" 11	" 29	" 17	8.5	m	s d c	d s	9	9
Springdale	b	9	" 12	June 1	" 17	8.5	l	r c-l c	b s	8	8
Standard	b	7	" 13	May 29	" 19	8 5	l	r c	d c	9	8
Staples	b	8.5	" 7	" 24	" 15	6	s	l c	v d c	9	8.5
Sunnyside	p	8.8	" 11	" 29	" 21	8.5	l	b c	l s	8.5	8
Surprise	b	8	" 13	" 29	" 17	8	l	l c	b s	8	8 5
Swindle	p	8	" 7	" 26	" 21	6	m	r c	c	7	9

TABLE No. 1.—STRAWBERRIES.—CONCLUDED.

Variety.	Sex.	Vigor (1-10).	Date bloom.	Date first ripe fruits.	Date last picking.	Productiveness scale (1-10).	Size.	Form.	Color.	Quality.	Firmness.
Tennessee Prolific	b	7	May 12	May 29.	June 15.	7	m to l	r c	d c	9.5	9
Thompson No. 84	p	8.5	" 12	" 29.	" 19.	9	m	r c	b c	8	8
" " 40	p	9.5	" 11	June 1.	" 23.	9.5	m	r c	b c	8.5	8.5
" " 64	p	7.5	" 7	May 29.	" 15.	8	m to l	i r c	b d s	8.5	9
" " 66	p	8.5	" 12	" 29.	" 15.	8.5	l	l c	b d c	8	8
" " 108	b	8.5	" 7	" 26.	" 17.	9	l	r d c	v d c	9 4	9.5
Timbrell	p	6	" 11	June 1.	" 23.	8	l	r c	v d c	8.5	8
Tonga	p	8.5	" 12	" 1	" 17.	8.5	m	i r c	s	8	9
Topeka	b	8.5	" 7	May 29.	" 21.	9	m to l	l c	d c	8	8 5
Warfield	p	9.8	" 7	" 24.	" 15.	9	m	l c	d c	8.5	9
Weston	p	8.5	" 18	June 1.	" 21.	8.5	l	b c	b c	8	8.5
Williams	b	8	" 12	May 29	" 15.	8.5	m to l	r c	d c	9.5	8.5
Woolverton	b	7.5	" 12	" 29	" 17.	8 5	m	l c	d c	8	9
Wyatt	b	7	" 7	" 29.	" 15	8.8	m	r c	d c	9.5	8.5
Yates	b	9 2	" 6	" 26	" 15.	7	l	r b c	l s	9	7
Zula	b	5	" 6	" 26.	" 15.	8.8	m	l c	d c	9	8

The following sorts fruited for the first time on the college grounds during the past season:

Acem. Perfect. Plants received from John Little, Granton, Ontario. Plants of very strong growth, blossomed full, but few blossoms set fruit and the berries were very small and imperfectly formed. The quality is good but the berry is soft. Needs further trial.

Apache. Perfect. Plants from Stayman & Black, Leavenworth, Kan. Blossomed very full but little fruit set. The fruit is long conical in form, color light scarlet, seeds prominent, flesh light and very poor in quality. Fruits develop imperfectly. Worthless from this season's trial.

Brooke Seedling. Imperfect. Plants from F. W. Brooke, Ithaca, Mich. The plants are growing in a poor location, hence vigor of growth and productiveness cannot properly be determined. Set well with fruit for plant growth. The fruit is large, broad, depressed conical in form, dark crimson color, seeds yellow, flesh very dark and of high quality, moderately firm. Size of berry holds out well to close of season. The handsome appearance and high quality of the fruit and the promise shown in growth and productiveness speak well for the future of this sort.

Bryant. Perfect. Plants from Birdseye & Son, Hopewell, N. Y. Plants of strong growth, healthy. Blossomed full and set well with fruit. Berry of large size, short, depressed conical, somewhat irregular in form, very dark crimson color, flesh dark and of fair quality, though somewhat acid, very firm. A very promising market sort.

Carrie. Imperfect. Plants from Thompson's Sons, Rio Vista, Va. Plants did not show up well last fall but the spring growth was good. Fruit medium to large in size, long conical form, dark crimson color, quality fair and moderately firm. Last fruits often imperfect. In poor location and but few plants. Must try again to judge properly.

Columbian. Perfect. Plants from Slaymaker & Son, Dover, Del. Plants of low, stocky, vigorous growth. Few blossoms came out but most of them set fruit. Berry large, round short conical form, light scarlet

color, flesh light and fair in quality, moderately firm. But few plants, scarcely enough to judge fairly of the variety.

Earliest. Perfect. Plants from Thompson's Sons. Plant of very strong, vigorous growth. Blossomed very full but did not set much fruit. This was the first variety to ripen fruits. First berries very large, round conical form, light scarlet color, flesh light and of poor quality; most of the fruits are hollow and soft. A seedling of Michel's, and like its parent good for but one or two pickings, after which it produces only small and imperfectly formed fruits. If valuable at all it is only so for its extreme earliness.

Enormous. Imperfect. Plants from W. F. Allen, Jr., Salisbury, Md. Plants of very strong, upright, vigorous growth. Fruit very large in size, short round conical form, very bright scarlet color, good quality and moderately firm. Valuable for vigor of plant growth and productiveness, for the handsome appearance, good quality and moderate firmness of berry. A sort of much promise.

Graham. Perfect. Plants received from C. W. Graham, Afton, N. Y. Plants of fair growth. Many blossoms failed to set fruit. Berry of medium size, round conical form; flesh dark, juicy, but quite acid, firm. Last fruits are small in size. Berry parts too easily from calyx. Not of special merit, though worthy of trial.

Holland. Imperfect. Plants from L. J. Farmer, Pulaski, N. Y. Plants are scattering, were filled in last fall and did not get well started. A few plants set a moderate amount of fruit. Berry long, somewhat broad conical in form, dark crimson color, flesh dark, of good quality and firm. Fruits do not ripen well on unexposed side. Needs further trial.

Hull's No. 3. Perfect. Plants from E. J. Hull, Olyphant, Pa. Plants are of low, healthy growth; blossomed very full but the largest proportion failed to set fruits. Fruit large, short depressed conical form, light scarlet color, flesh pink, of good quality and moderately firm. Berries ripen evenly but are light colored. No qualities of special prominence.

Jarbalo. Imperfect. From Stayman & Black, Leavenworth, Kan Plants are not in good location but still vigorous. Fruit medium to large in size, round conical form, color dull scarlet, not of high quality and moderately firm. Fruit lacking in attractive appearance and quality. Under better conditions would be a sort of some promise.

Kansas (Prolific). Perfect. Received from Stayman & Black. Plants are scattering in row, in a poor location, but are much ahead of any other variety near them under similar conditions. Blossomed full and set well with fruit for plant growth. Fruit of good size, round, conical form, dark crimson color, high quality and moderately firm. Promising, but needs further trial under more favorable conditions.

Kossuth. Perfect. From Stayman & Black. Plants of good growth, blossomed full and set a fair crop of fruit. Berry large in size, irregular, depressed broad conical form, dark crimson color. Flesh dark, of excellent quality and firm. Promising for market or home use, because of handsome appearance, high quality and firmness of berry. Productive.

Mary. Imperfect. Plants received from Edw. W. Cone, Menominee, Wisconsin. Plants are not of strong growth. Fruit large, form broad, depressed conical, color bright crimson, firm but very acid. The decided sourness of the berry is a strong point against it.

Meridian. Imperfect. Sent by Stayman & Black. Plants quite strong and vigorous and set well with fruit. Berry large in size, round conical

form, dark, somewhat dull crimson in color, flesh dark but rather coarse, lacking juice and quality, moderately firm. Valuable for lateness in ripening bulk of crop, regular size and form. Lacks quality.

Ona. Imperfect. From Edw. W. Cone. Plants of strong, healthy growth. Fruits medium to large in size, short round conical form, regular, color a bright dark scarlet, seeds yellow, prominent, flesh dark, juicy, of high quality and quite firm. Its handsome appearance and its high quality and firmness make it worthy of trial for home or market use. In productiveness, however, it is but little above medium.

Orono. Imperfect. Plants received from John Little, Granton, Ont. Plants of strong, healthy growth. Fruit large, round conical, bright dark crimson color, quality good and flesh firm. Very attractive in appearance, and its quality and firmness are well up, but so far the sort has not made a good showing in productiveness.

Oscar. Perfect. Plants from Thompson's Sons. Plants of low stocky growth and very healthy. Fruit large, round conical form, often irregular, very dark crimson color, seeds yellow, large and prominent; flesh very dark, good quality and firmness with the best. It would be an excellent market sort if more productive, because of attractive appearance, good quality and firmness.

Ostego. Imperfect. Received from Thompson's Sons. Plants of fair growth, did not blossom very full but set well with fruit, some berries imperfect. Fruit of good size, round depressed conical, regular form, light scarlet color, seeds sunken, flesh light and lacking flavor. Not of special merit.

Paris King. Perfect. Plants received from W. F. Allen. Growth in row scattering, individual plants fair. Few blossoms but set well with fruit. Berry large, round conical, dull scarlet color, flesh light, of fair quality and firmness. Its color is against it and it seems to lack productiveness. Further trial is necessary to form an opinion.

Sherman. Nearly imperfect. From Edw. W. Cone. Plants of low growth, foliage very dark green. Blossomed very full and set a large amount of fruit. Berry large, short round conical form, dark crimson color, seeds dark, thickly set, prominent, flesh rather light, of fair quality and firm. Fruit does not ripen well at tip and often imperfect there. Plants have not foliage enough to develop and cover fruit properly, though lack of plant growth may be largely due to poor location. A very productive sort.

Smalley. Imperfect. Plants from C. W. Graham, Afton, N. Y. Plants are of low, stocky growth and healthy. Berry medium to large in size, form regular round conical, color dark, somewhat dull crimson, flesh dark juicy, acid but very firm. Ranks high in productiveness, is of fair appearance and the berry would stand shipment well. Promising as a market sort.

Splendid. Weakly perfect. From Matthew Crawford, Cuyahoga Falls, Ohio. Plants of low growth but strong and healthy. Berry below medium size, short depressed conical form, color dull scarlet, flavor quite acid but good, firm. Lacking in size of berry and attractive appearance, otherwise good. Try again.

Staples. Perfect. Received from Crawford and Cone. Plants of good growth. Blossomed full but few fruits set and most of those imperfect. Needs further trial.

Thompson No. 103. Perfect. Plants from Thompson's Sons. Plants of excellent growth, blossomed full and set a large amount of fruit. Berry large, round, depressed conical; color, very dark crimson; flesh, dark, juicy and of good quality, quite firm. The plants are productive, the berry of good size and appearance, ripens well and is of fine quality. A promising sort.

Wyatt. Perfect. Received from Ezra G. Smith, Manchester, N. Y. Growth good for location. Blossomed full and set a large amount of fruit. Berry of medium size, round, conical form, dull crimson color, excellent quality and quite firm. Last of crop rather small and some berries did not develop. Regular form and fruit of high quality. Promising.

Yates. Perfect. Plants from Stayman & Black. A strong, vigorous grower. Blossomed full but failed to set much fruit. Berry large, round or broad conical, light scarlet color, flesh light and of mild flavor, soft and berries often hollow. Color against it, too soft and rots at tip before ripening.

Zula. Perfect. From Stayman & Black. In poor location, plants did not get a good start. Blossomed very full and set a large amount of fruit for plant growth. Berry of medium size, long conical form, dark crimson color, flesh dark of good quality and moderately firm. In color, form and quality this variety ranks high. Scarcely enough of plant growth to judge of productiveness.

NEW VARIETIES OF 1895.

Aroma has shown itself to be a valuable market sort. The plants are productive, the berries are large to the end of a long season and are firm enough to stand shipment well. Its season is with the later sorts.

Bixler did not set well with fruit. The plant is one of the best growers in the patch and the fruit is of very high quality. It is bisexual and the season was adverse for fruit setting.

Cyclone is valuable for good appearance, high quality and firmness of berry, and for vigor of plant growth.

Early Jack fruits turn dull yellow and rot before ripening; poor in quality and soft. Early, but of no particular value.

Edith. Season late. Berry large, of good quality and firm. Holds out well in size to close of season.

Fred Stahelin. A most promising sort for home use or near market, because of the handsome appearance and high quality of the fruit. Productive, but last fruits are small.

Kyle No. 1. The fruit is soft and of poor quality. Hulls easily and is dry at place of parting. The fruit truss is upright and the berries are borne beyond leaves, so easily injured by frost and sun.

Longfield again proves itself a very promising market sort, will stand shipment well and is attractive in appearance. It ranks among the first in productiveness and the plants are fine growers.

Marshall. Another season's trial of this sort confirms the good opinion we have formerly expressed. The large uniform size of the berry and its good quality and firmness make it a good home and market variety. The larger fruits are inclined to be irregular and the plants are subject to rust.

Maxwell did not set so well with fruit as the previous season, probably on account of its being nearly bisexual. The berry is attractive in appearance and of very high quality and firmness. It is quite sure to reach a prominent place.

No Name is of the strongest growth though scarcely up to the standard in productiveness. The berry is very handsome in appearance and high in quality and firmness. Seems to be a sort of some promise.

Phillip failed to set fruit well and many of the berries were imperfect. The berry is attractive in appearance but is not of high quality and it lacks firmness. Probably will not occupy a very prominent place.

Rio made an excellent showing last year; this season the crop was small in both size of berry and quantity produced.

Robinson lacks quality and firmness of berry, otherwise it takes high rank.

Shawnee ripens slowly and unevenly but otherwise it is a variety of some promise.

Shuckless parts from calyx easily, though no more so than Kyle No. 1. Berry dull in color, of coarse texture and lacking juice, though the quality is fair. Of little promise.

Snowball is of strong, healthy growth and the plants are productive. The fruit is handsome in appearance and a good shipper. A very promising market sort.

Springdale plants are of good growth; the berry is of fine appearance, though scarcely as firm as last season. A good sort, though nothing to give it special prominence.

Tennessee Prolific are in a poor location but set well with fruit in proportion to plant growth. The berry is attractive in form and color, of high quality and quite firm. If the variety proves productive it will be a valuable sort.

Timbrell, because of unevenness in ripening and spotted appearance of fruit will not occupy a prominent position among the many better new sorts now before the public.

Thompson's Nos. 40 and 64 have again shown themselves to be valuable sorts. No. 40 is particularly promising for the handsome appearance of the fruit and the vigorous growth and productiveness of the plants.

Tonga set well with fruit, but the berries do not ripen well, are irregular in form and dull in color. Further trial necessary.

Of the older sorts and among those tested for several seasons the following are worthy of special mention:

Clyde. Though we have grown this sort for several years and considered it to have considerable promise, it was not until the past season that it showed up remarkably well. While the plants are not of strongest growth, yet they bore the largest crop of any variety in the field. The berries are of good size and very regular in form. The color is rather light and the flesh is less firm than desirable. If it continues to be as productive as during the past season, it will be a profitable market variety.

Wm. Belt is another variety that has shown up much better than in previous seasons. The berry is large, of good form and color and is firm enough to stand shipment well.

Bird, Greenville, Leroy, Weston and Williams are excellent in plant forming properties and the berries make a good appearance in market. As these sorts rank high in productiveness, they are well worthy of trial in comparison with the older market varieties. Epping is a little light in color, otherwise a fine market sort.

Varieties for home use or near market should be strong in plant growth, productive, attractive in appearance and high in quality. Belle of Lacrosse, Brandywine, Brunette, Huntsman, Iowa Beauty, Mrs. Cleveland,

Princeton Chief and Topeka possess the above qualities and are recommended for the purpose named. Bubach, Crescent, Haverland and Warfield are yet the leading imperfect flowering sorts planted by the general grower. Beder Wood, Sharpless, Wilson and Woolverton are excellent pollenizers for the above sorts and are also valuable market berries. Belle, Gandy and Parker Earle are among the best late ripening varieties.

Many varieties, of which no special mention is made, are sorts of considerable merit and possess qualities that under other conditions might place them in the front rank.

RASPBERRIES.

The drouth of last summer together with the extreme cold of the winter left the canes in so weakened a condition that the anthracnose could not be kept wholly in check. Cuthbert and most of the red sorts were killed nearly to the ground. Many varieties suffered severely in decreased productiveness and in the smaller size of the berries.

TABLE No. 2.—BLACK AND HYBRID RASPBERRIES.

ABBREVIATIONS.

Size.	Form.	Color.	
s, small	r, round.	b, black.	g, glossy.
m, medium.	c, conical.	p, purple.	l, light.
l, large.	o, ovate.	o, orange.	pu, pubescent.

Variety.	Per cent of winter injury.	Date bloom.	Date ripe.	Productiveness (1-10).	Size.	Form.	Color.	Quality.
Ada	.20	May 28.	June 24.	6.5	m	r	g b	8
Caroline	.35	" 28.	" 22.	7.0	m	r	l o	8
Columbian	.50	June 1.	July 2.	8.0	l	r o	p	8.5
Conrath	.35	May 20.	June 24.	9.5	l	r	b	8
Cromwell	.85	" 20.	" 28.	5.0	m	r	b	8
Ebon Beauty	.50	" 22.	" 24.	5.0	m	r c	b	7
Farnsworth	.20	" 19.	" 22.	9.3	l	r	b	8.5
Gregg	.50	" 22.	" 26.	8.5	l	r	b pu	7
Green's New Raspberry	.85	" 23.	" 26.	.....	l	r	b pu	9
Hopkins	.70	" 21.	" 22.	6.0	m	r	b	8.5
Kansas	.20	" 20.	" 24.	9.7	l	r	g b	8.5
Lovett	.50	" 18.	" 24.	8.5	m	r	b	8.
May King	.20	" 20	" 24.	5.5	s	r c	b	7.5
Mills' No. 15	.85	" 20.	" 25.	.....	.....	.....	.....	.....
Nemaha	.75	" 25	" 28.	8 0	l	r	b pu	7
Ohio	.85	" 19.	" 24.	8.5	l	r	b	6
Older	.20	" 22.	" 24.	9.2	l	r	b	9
Palmer	.50	" 18.	" 18	8.5	m	r	b	8.5
Progress	.65	" 20.	" 22.	5.0	s	r	b	8.5
Shaffer	.75	June 1.	" 28.	7.8	l	r s	p	8.5
Smith	.75	May 22.	" 20.	5 0	l	r	b	9
Virginia	.85	" 18.	" 22.	7.0	l	r c	b	8.5
Winona	.85	" 20.	" 24.	8.2	m	r	b	8

NOTES ON VARIETIES.

Ada did not make so good a showing this season as in the previous one. The canes made a weak growth and were badly attacked with anthracnose.

Caroline. The fruit is a dull yellow color and rather insipid in flavor; too soft for market.

Columbian. A variety resembling Shaffer somewhat in general characteristics, but its cane growth is stronger and the berries are firmer and a little better in quality. As grown here it slightly leads Shaffer in productiveness.

Conrath. We have grown this variety for several seasons and have found it uniformly productive. The berries are large in size, the quality good, and they hold out well. The canes were healthy, but little disease showing. Its season is medium early.

Farnsworth. This variety stood the winter well and was quite free from disease. The fruit is large, firm and of good quality. An excellent variety for home use or market.

Gregg. The best late market sort. The canes are lacking in hardiness, and it should only be placed in high, well-drained soil.

Green's New Raspberry. This was the first season of fruiting. The growth is healthy. Berries of good size, deep black in color with some fuzz; seeds small. The fruit is not very firm but is of high quality. Not enough growth or fruit to judge of merits.

Kansas. For another season this was the most productive black cap grown. The canes were hardy and but little troubled with disease. The fruit is large, of fine appearance, and firm though not of best quality. One of the best medium season market berries.

Lovett. The canes are not hardy and are quite subject to anthracnose. The bushes bore a fair crop of fruit but the berries were small and lacking in flavor.

Mills' No. 15. Fruited for the first time this season. Fruit is large, jet black in color with some bloom, the seeds are small. In season a little earlier than Gregg; berry not as large, with less bloom, not so dry or so firm, but better in quality. The bushes are of good growth, healthy and productive. It is a promising variety.

Ohio. The leading variety for evaporating purposes.

Older. This variety is very vigorous and healthy in cane growth, and bears a large crop of fruit which holds its large size to close of season. If the berry were firmer it would make a most excellent market sort. Valuable for home use or near market.

Palmer. One of the best early market sorts.

Shaffer. For canning and home use this variety has few superiors among the better known sorts. The canes were badly injured by winter and anthracnose, and this is a common failing of the variety.

Winona. This variety made but little cane growth during the season, though bearing a fair crop of fruit. The variety seems to possess no prominent qualities, but will be given further trial.

Cromwell, Ebon Beauty, Hopkins, Jackson's May King, Progress, Smith, and Virginia, were weak in cane growth, badly affected with anthracnose, and bore but a small crop of fruit.

TABLE No. 8.—RED RASPBERRIES.

ABBREVIATIONS.

Size.	Form.	Color.
s, small.	r, round.	d, dark. o, orange.
m, medium.	c, conical.	r, red. b, bright.
l. large.	o, ovate.	p, purple.

Variety.	Per cent of winter injury.	Date bloom.	Date ripe.	Productiveness (1-10).	Size.	Form.	Color.	Quality.
Cuthbert	.65	June 4.	June 24.	8.8	l	r c	r	8.0
Gladstone	.80	May 29.	" 22.	5.0	s	r c	d p	8.0
Golden Queen	.70	June 2.	" 26.	5.0	l	r c	o	9.5
Hansell	.50	May 26.	" 22.	6.0	m	r	d r	9
Kenyon	.35	June 1.	July 10.	----	l	r c	d c	9.5
King	.85	May 23.	June 22.	6.5	----	----	----	----
Loudon	.25	" 30.	July 10	----	l	r c	d c	9.5
Marlboro	.50	" 28.	June 22.	6.0	m	r	r	8.5
Michigan Early	.25	" 26.	" 17.	7.0	m	r	r	9.0
Miller	.25	" 30.	" 28.	----	l	r c	b r	9
Nameless	.80	July 1.	" 22	6.5	m	r	r	8.5
Perry's Golden	.75	May 27.	" 24.	6.5	l	r c	o	9.5
Philadelphia	.50	" 25.	" 23.	5.0	l	r c	d r	9.5
Royal Church	.75	" 27	" 26.	5.5	l	r c	d c	8.5
Stayman No. 1	.70	" 31.	July 16.	----	l	r c	d c	9
Thompson	.75	" 25.	June 21.	5.0	m	r	d r	9.0
Turner	.20	" 23.	" 20	8.0	l	c	r	9.0

NOTES ON VARIETIES.

Cuthbert. Though somewhat injured by winter and anthracnose, this variety bore a fair crop, and it has no superior for general planting.

Gladstone. This variety was very disappointing the past season. The autumn crop was ruined by frost before maturing. Has a place as a novelty.

Golden Queen and *Perry's Golden* are quite similar in bush and fruit. They are valuable as dessert varieties.

Hansell and *Michigan Early* may find a place to a limited extent as early ripening sorts.

Kenyon. New. Canes large and stout, and nearly free from spines; leaflets are large, broad, of a dark green color and quite far apart on canes. The fruit is large, round conical, rich dark red color, and of high quality. The berry is very attractive in appearance and firm. As it ripened this season it was a week later than Cuthbert. For the strength of the plants the crop was a large one.

Loudon. New. As close a comparison as it was possible to make between Loudon and Kenyon shows them to be nearly, if not quite, identical in cane growth and fruit. Both sorts were planted quite late in the spring of the previous year and the growth was not large nor the fruits abundant. Perhaps another year's growth may bring out some differences. The plants are quite hardy, and it is a very promising variety, either for home use or market.

King. New. Scarcely enough cane growth and fruit to judge properly of this variety. Closely resembles Hansell.

Marlboro. Canes of small growth and quite badly diseased. Usually productive and largely planted as an early berry.

Royal Church. The fruits are of a dark, rich red color, very handsome in appearance, and of good quality, but crumble so easily that they are picked with difficulty. The bushes are moderately productive.

Stayman No. 1. New. Canes of strong, healthy growth, and thickly set with short, stiff spines. Foliage closely of *Idæus* type. The leaflets are very large, and being set very close, nearly cover the entire cane. Berries large, short round conical in form, and of a bright dark red color. It is quite acid in quality, but pleasant. The fruits are a little inclined to crumble. Judging from the first fruiting it promises to be very productive. The season is late.

Turner. The bush is hardy. The fruit soft but of high quality. Valuable for home use or for near market.

BLACKBERRIES.

The winter of 1895–6 was so severe as to kill the canes of many varieties to the ground. No variety produced more then one-tenth of a crop. The following partial notes may have some value in determining the hardiness and adaptation of certain sorts to our climate.

Eldorado stood the winter best of any sort grown, but the fruits borne were so imperfect and small in quantity that no definite results as to the fruiting qualities could be obtained. That it is equally as hardy as Snyder has been well shown by the severe tests of the two past seasons.

Taylor and *Snyder* were the two other sorts on which, it could be said, fruits were borne, but the yield was very small.

The following sorts bore a few small, imperfect berries: *Early Cluster, Erie, Lincoln, Minnewaski, Ohmer, Stone's Hardy, Thompson's Mammoth,* and *Wilson, Jr.*

Agawam, Childs' Everbearing. Early Harvest, Early King. Ford's No. 1, Jewett, Kittatinny. Lovett's Best, Maxwell, Wachusett, White Blackberry and *Wilson's Early* bore no fruits.

Lucretia dewberry, because of its trailing habit, stood the winter better than did the blackberries. It did not bear a full crop, but the berries were very large, and, while quite acid, were still pleasant in flavor.

GRAPES.

The College vineyard comprises over one hundred varieties. Many have not yet fruited. Owing to the numerous depredations committed, it was impossible to get complete notes on the time of ripening, quality and productiveness of all the varieties. The following are, therefore, not as full or as valuable as they would otherwise be.

NOTES ON VARIETIES.

Berckmans. Clusters are small in size, flat at base and rounding to apex where grapes are set closest. Grape is medium in size, round or slightly oblate, not firmly attached to stem, but does not drop easily, color a rich, purplish red. The quality is high and both vine and cluster were free from disease. Season with Concord.

Black Pearl. Bunches will average small, though many are of fair size; very irregular in shape. Grapes are small, round, set close with short stems; color blue-black. The pulp is tough and very acid. The cane and foliage are healthy and the variety was the most productive in the vineyard. Season middle of September.

Brighton. Usually considered one of the best red grapes for home use or market. This season the clusters were small and nearly every grape cracked and dropped off before fully ripening. Season with Concord.

Cottage. Clusters short and close. Grape is medium in size, round, blue-black color; the skin is tough and the pulp solid and of good quality. The variety is healthy in plant and fruit, but the clusters are too small, the grape is lacking in juice and drops too easily from stem. Season a week earlier than Concord.

Early Dawn. Clusters small, single stemmed and closely set with grapes. Berry of medium size, light-red in color, with thin, almost transparent skin. The canes are fairly productive of small clusters and the quality is very fine; the grapes however, crack and drop badly if not picked as soon as ripe. A week earlier than Concord.

Early Victor. The canes are of good growth and bear a fair crop of small sized clusters. The grapes are blue-black in color and of fair quality. The variety is one of the earliest and has a place in the family vineyard. Season, two weeks earlier than Concord.

Geneva. Cluster of medium size, single stem with grapes set evenly and closely, making an attractive bunch. Berry is of good size, round, light-green color and of high quality. The vine and fruit is healthy and the grapes do not crack, but hang firmly to the stem. The variety is scarcely productive enough for a market sort, but its early ripening, good appearance and high quality make a place for it in the family vineyard. A week earlier than Concord.

Hayes. Cluster of medium size, well-formed and close. The grape has a thin skin and cracks easily; color a light golden yellow. In quality it is sweet and melting, very fine. If more productive and the vine a better grower, it would take rank among the first table sorts. A week earlier than Concord.

Jewell. Very healthy and productive, though clusters are small. The berry is small to medium in size, blue-black in color with considerable bloom, pulp rather tough but of good quality. Cluster and grape too small. Season of Concord.

Martha. Vine healthy and productive of some fine clusters. Berry of medium size, round, light-green in color. The quality is good, but quite foxy. The variety is rather late in ripening. A week later than Concord.

Massasoit. The canes were unproductive and the clusters small. Considerable mildew and anthracnose made an appearance and the berries dropped. Season with Concord.

Moore Early. Cane growth strong. Healthy in foliage and fruit. Quite certain to make large, well-formed bunches. One of the best early market black grapes. Two to three weeks earlier than Concord.

Moyer. The grape is of very fine quality, but only imperfect clusters were formed. The grapes cracked and dropped before ripening. Season of Concord.

Niagara. This is the leading white market grape. The canes are strong growth and productive and the fruit and foliage usually free from disease. A little later than Concord.

Rochester. Cluster short, compact, well rounded at end and usually with a well developed shoulder. Grape of medium size, oblate, with short stem and strong attachment. Did not ripen sufficiently to judge of color and quality. A few days earlier than Concord.

Rockwood. Clusters quite large, not shouldered, close and compact. Berry of medium size, round, color a deep blue-black, skin thick and tough, pulp rather coarse and lacking in juice, but of fair quality. The vine is healthy, of strong growth and productive. The bunch is of good size and form and the berry will stand shipment well, does not drop from stem. The season is early. A good market grape. Season a few days later than Moore Early.

Winchell. Clusters of good size, often quite double, close. Berry of medium size, round, light-green, skin thin and often cracks before ripening, pulp sweet, melting and of very fine quality. The variety is early in ripening, productive and is one of the best white grapes for the home vineyard. A few days later than Moore Early.

Worden. This variety is from a week to ten days earlier than Concord. The vines are vigorous, healthy and productive. The grape is of better quality than the Concord. The variety has a place in every vineyard whether planted for home use or market.

NOVELTIES.

During the past three or four years several new varieties of fruits have been placed upon the market that are either hybrids or of species that have not before been cultivated in this country. Most of them have been tested here, and thus far none have shown promise of value for any purpose whatever. The following are the varieties tested:

Mayberry (*Japanese Golden*). The plant resembles the red raspberry, and was raised by Luther Burbank by crossing *Rubus palmatus* and the Cuthbert raspberry. It is claimed by the disseminators to form a bush six or seven feet high, and the fruit is said to ripen a month before the earliest raspberries. We have made two attempts to test this variety, but in both cases the plants failed to grow. Those obtained last spring were from southern New Jersey, but the tops had been killed to the ground by the winter, and the roots were too weak to send up shoots. Judging from this experience the plant will not stand our climate.

Loganberry (Raspberry x Blackberry). This is supposed to be a hybrid between the Aughinbaugh, a California blackberry and Red Antwerp raspberry. The plants are spreading and the leaves and canes greatly resemble the European raspberry, the latter being covered with prickles. The fruits resemble the blackberry in shape and structure, but are red when ripe. The plants seem about as hardy as our common

varieties of blackberries, and they formed a few fruits last year on two-year old plants, but they have shown no valuable characteristics.

Strawberry-Raspberry (*Rubus sorbifolius*). This is a recent novelty from Japan. It sends up stems to the height of twelve or fifteen inches, which are covered with short, stout spines, as are the ribs of the leaves. The old stems die down each year and new ones are sent up from the roots. As grown here it seems to have no value, and as it suckers profusely it may become difficult to eradicate when it has obtained a hold of the soil.

Wineberry (*Rubus Phœnicolasius*). Another Japanese species introduced and quite widely disseminated several years ago. It seems to be wanting in hardiness as it has killed to the ground nearly every year. The canes are somewhat spreading, and are covered with numerous reddish, purple hairs. The calyx is quite large and thick, and forms a sort of burr about the berry. The fruit is of a dark amber color, and is soft and rather acid. Of no value except as a curiosity.

AGRICULTURAL COLLEGE, MICH.,
January 1, 1897.

FRUIT TESTS AT SOUTH HAVEN.

REPORT BY T. T. LYON.

To Prof. L. R. Taft, Horticulturist:

SIR—As during the years 1894 and 1895, so during the spring of 1896 there was no adequate rainfall in this immediate vicinity until the middle of July. This necessitated hauling water by team for irrigating such plants as were not yet well established. This continued until July 7th, at which date the mains of the village water works became available, and a permanent supply upon the premises was secured, although the use of a team with barrels was yet necessary when water was to be applied beyond the reach of a hose. Since the occurrence of the copious rains, above referred to, however, resort to the artificial application of water has rarely been found necessary.

For the double purpose of subduing weeds and maintaining a surface mulch of mellow earth, free use has been made of the Acme cultivator among the older trees, and of a fine toothed one, or a Planet, Jr., among younger trees and small fruit plants, especially after the occurrence of rain. This was continued until about the middle of August, after which all cultivation was discontinued, except in a few special cases.

The entire plantation was sprayed in early spring, while growth was yet dormant, with a solution of a pound of copper sulphate in twenty-five gallons of water. This was applied to gooseberries and currants (which start very early) on March 10th, and to all other small fruits prior to April 17th. For the purpose of comparison, only alternate trees of the cherries, peaches and plums, in the southwest block were treated, commencing with the first. Later examination shows a slight difference only, in favor of the sprayed trees, in a few cases.

Subsequent sprays were applied at sundry times during the season for various purposes. These will be noticed under the heads of the several fruits to which such applications were made.

The rules of pomology of the American Pomological Society (which are also the rules of the National Division of Pomology), are rigidly applied in the nomenclature of fruits, objectionable words being added in brackets only when deemed needful to avoid ambiguity, but with the hope that ultimately they may be wholly omitted, in the interest of simplicity, brevity and correct taste.

The weight, in ounces, of an average specimen of each variety is given as indicating the comparative importance thereof; this being deemed to be a more accurate expression of the comparative values of varieties than the crude indication of size usually employed.

Quality is expressed upon the scale 1 to 10, the latter, in all cases, being the maximum.

The several classes or species of fruits are considered, as nearly as practicable, in the order of their ripening.

STRAWBERRIES.—(*Fragaria.*)

The station grounds are now so fully occupied by tree fruit that unavoidably the last two year's plantings of strawberries have been alternated with rows of trees; obviously greatly to the detriment of the former, and this, coupled with the effects of the drouths of the two previous seasons, has conspired to render a comparison of results in the case of many, if not most, varieties, far from satisfactory.

Conscious, therefore, that any comparison of varieties based upon the actual products of this season would under these conditions prove more or less misleading, reports upon several varieties are deferred to await farther trial; and estimates (upon the scale of one to ten), are given in the following tabulation, with reference, as far as practicable, to imperfect stands of plants as well as to the more or less unfavorable conditions otherwise. The product of the plant planted in 1895 and that planted in 1894, are compared in the following table.

Both plats were sprayed between April 13th and 17th last, with a solution of one pound of copper sulphate in twenty-five gallons of water. After the fruit had been gathered the 1895 plat was sprayed, to prevent rust, with a solution of one pound of copper sulphate in two hundred and fifty gallons of water; and the 1894 plat was plowed under, preparatory to seeding at the proper time, with crimson clover.

So far as the strawberry plats are concerned, no insects have proved troublesome during the season.

The weather having been dry during the latter part of last season with much strong wind, many varieties of strawberries in exposed portions of the younger plat were nearly covered during August and September with drifting sand. Many, thus buried, were partially uncovered, though unavoidably more or less injured in so doing, and the whole were well mulched before the advent of winter. Many of them, however, were practically dead when uncovered at the opening of spring; among which were several entire varieties. Neither originators nor introducers of novelties usually supply adequate descriptions in submitting them for trial. Hence the station can only assume that the plants received are genuine. For this reason, and on account of variations often due to differences of climate, soil or other cause, no definite descriptions of such variable characteristics is attempted.

Weight (from which size may be inferred), is arrived at by taking the weight of a considerable number of specimens and dividing the total by the number weighed. In the case of this season's crop, however, conditions have been so unfavorable that such weights are believed to be more or less misleading, and are therefore generally omitted.

TABULATION OF STRAWBERRIES FROM PLATS PLANTED IN 1894 AND 1895.

Number.	Names.	Sex. b—bi-sexual. n—nearly. p—pistillate.	First planted.	First bloom.	First picking.	Last picking.	Productiveness. First crop—Scale (1-10).	Productiveness. Second crop—Scale (1-10).	Vigor of plant—scale (1-10).	Weight of average berry in ounces.
1	Acem	b	1895	May 4	May 27	June 16	8	----	9	1-5
2	Afton	p	1892	" 4	" 29	" 16	8	6	9	----
3	Allen	b	1895	Apr. 30	" 29	" 22	2	----	8	⅕
4	Allen 5	p	1894	May 4	June 1	" 11	1	----	10	----
5	Allen 6	p	1894	" 5	" 8	" 16	2	----	10	⅕
6	Allen 13	p	1894	" 5	" 1	" 16	1	----	10	⅕
7	Aroma	b	1894	" 9	" 5	" 13	1	5	9	----
8	Auburn	p	1892	" 9	" 8	" 19	2	8	8	----
9	Banquet	p	1892	" 4	----	----	----	8	6	----
10	Barton	p	1891	" 6	----	----	----	8	6	----
11	Beauty	b	1892	----	----	----	----	8	----	----
12	Belt 3	b	1895	May 4	June 8	June 23	8	8	9	----
13	Beverly	b	1892	" 5	" 1	" 16	2	2	9	----
14	Bickle	p	1894	" 5	May 29	" 20	8	8	6	----
15	Boynton	p	1894	" 5	" 29	" 18	2	2	10	----
16	Brandywine	b	1893	" 7	June 8	" 22	2	8	10	----
17	Brunette	b	1893	" 8	----	----	----	1	9	----
18	California	b	1891	----	----	----	----	2	----	----
19	Cameron 2	b	1894	May 6	----	----	----	2	2	----
20	Cameron 6	n p	1894	----	----	----	----	2	2	----
21	Cameron 13	p	1894	May 7	----	----	----	5	1	----
22	Cameronian	p	1892	----	----	----	----	3	----	----
23	Carrie	p	1895	May 6	June 5	June 27	2	----	6	----
24	Chairs	p	1893	" 5	" 5	" 18	----	7	7	----
25	Chairs E. S. B.	b ?	1895	" 12	----	----	1	----	1	----
26	Champion (Eng.)	b	1895	" 10	June 5	June 16	8	----	8	⅕
27	Charlie	p	1894	" 8	----	----	----	10	8	----
28	Cheyenne	p	1894	" 5	June 5	June 22	4	5	9	----
29	Clark	b	1892	" 4	" 1	" 20	1	2	8	----
30	Cleveland	p	1888	" 6	" 1	" 20	2	1	9	----
31	Columbia	b	1894	" 2	" 1	" 18	2	2	9	----
32	Concensus	p	1893	" 11	" 5	" 22	2	2	10	----
33	Copernicus	p	1893	" 11	----	----	----	2	9	----
34	Crescent	p	1888	" 6	May 29	June 20	1	2	8	----
35	Cruse	b	1894	" 7	----	----	----	4	9	----
36	Curtis 15	b	1892	" 6	----	----	----	8	6	----
37	Curtis 159	p	1892	" 12	----	----	----	8	6	----
38	Cyclone	b	1894	----	----	----	----	2	----	----
39	Daisy	p	1890	May 7	----	----	----	1	1	----
40	Dan Bisel	b	1894	" 4	June 1	June 22	8	8	10	1-5
41	Dayton	b	1892	" 6	May 29	" 20	4	1	10	----
42	Earliest	b	1895	" 4	" 27	" 16	4	----	10	¼
43	Early Jack	b	1894	" 4	June 1	" 20	6	8	10	----
44	Edgar	p	1890	" 6	" 5	" 20	2	3	9	----
45	Edith	p	1894	" 12	----	----	----	2	5	----
46	Edwards	b	1894	" 6	June 1	June 22	1	2	6	----
47	Edwards (Fav.)	b	1894	" 8	" 5	" 22	8	8	6	----
48	Eleanor	b	1895	" 7	" 8	" 20	1	----	7	----
49	Enhance	b	1890	" 8	----	----	----	5	2	----
50	Epping	p	1894	----	----	----	----	4	2	----
51	Equinox	b	1894	May 8	----	----	----	2	----	----
52	Eureka	p	1888	----	----	----	----	3	----	----
53	Fairmont	b	1891	May 8	----	----	----	4	4	----
54	Feicht 2	b	1894	" 4	May 29	June 16	8	4	9	----
55	Feicht 3	p	1894	" 5	June 5	" 20	4	5	9	----

TABULATION OF STRAWBERRIES.—CONTINUED.

Number.	Name.	Sex. (b—bi-sexual. n—nearly. p—pistillate.)	First planted.	First bloom.	First picking.	Last picking.	Productiveness. First crop—scale (1-10).	Productiveness. Second crop—scale (1-10).	Vigor of plant—scale (1-10.)	Weight of average berry (scale (1-10).
56	Fir	b	1894	May 8	June 5	June 20	2	2	7	
57	Florence	b	1888					2		
58	Gardner	b	1895	May 5	June 8	June 20	2		8	
59	Gipsy	p	1894	May 6	May 29	" 30	4	6	10	
60	Glenfield	b	1894	" 4	" 29	" 13	1	2	6	
61	Greenville	p	1891	" 8				3	9	
62	Harmon	b	1891	" 6				3	10	
63	Hattie	p	1892	" 8	June 5	June 27	2	5	8	
54	Haverland	p	1887	" 27	" 3	" 16	1	5	9	
65	Hermit	b	1892	" 6	May 29	" 22	2	3	8	
66	Holland	p	1895	" 8	June 3	" 20	2		9	
67	Holyoke	b	1891					3		
68	Hugo	b	1891	May 6				2	1	
69	Huntsman	b	1892	" 8				2	2	
70	Hyslop	b	1892	Apr. 30	May 27	June 11	3	2	9	
71	Iowa	b	1892	May 7				1	2	
72	Irene		1895	" 4	June 1	June 20	3		9	1/4
73	J. S. 4	p	1894	" 5	" 3	" 20	4	6	10	
74	J. S. 6	p	1894	" 8	" 11	" 22	2	2	2	
75	Kansas	b	1894	" 7	" 13	" 22	3	6	10	
76	Katie	b	1892	" 7	" 3	" 20	1	2	9	
77	Klickita	p	1894	" 12	" 13	" 22	1	1	9	
78	Kossuth	b	1894	" 5	May 27	" 11	1	4	8	
79	Kyle 1		1895		June 3	" 23	2		9	1/5
80	La Crosse	n p	1893	May 11	" 3	" 23	1	2	6	
81	Leader	b	1892	" 5				3	2	
82	Lehigh	p	1891	" 6	May 27	June 22	2	3	7	
83	Leroy	p	1893	" 5	" 27	" 20	7	2	8	
84	Leviathan	b	1892	" 9	June 3	" 20	3	2	6	
85	Lincoln	p	1892	" 5	May 29	" 23	5	5	9	
86	Little 26	b	1894	" 7	June 3	" 22	2	3	9	1/5
87	Little 42	b	1894	" 8	June 1	" 22	2	4	8	
88	Longfield	p	1894	" 6	May 29	" 22	4	4	8	1-5
89	Lovett	b	1891	" 6	" 29	" 23	4	3	9	
90	Lower	b	1894	" 12	June 11	" 23	1	1	6	
91	Magnate	p	1894	" 5	" 8	" 18	2	1	8	
92	Marshall	b	1894	" 9	" 3	" 20	1	2	8	1/8
93	Mary	p	1894	" 12	" 13	" 13	1		9	1/5
94	Maxwell	b	1894	" 8	" 8	" 22	1	3	7	
95	Meeks	b	1894	" 4	May 29	" 5	1	2	9	
96	Miller	b	1890	" 6	June 8	" 20	1	2	9	
97	Monroe	b	1891					2		
98	Murray	p	1895	May 5	May 29	June 16	3		6	1/4
99	Muskingum	b	1892	" 8	June 1	" 20	6	4	9	
100	Mystic	b	1892	" 9	" 5	" 20	1		6	
101	No Name	b	1894	" 7	" 1	" 20	6	3	9	
102	No 31	b	1893	" 8			2		8	
103	Odessa	p	1894	" 6			1		9	
104	Ohio Centennial	b	1893	" 7	June 5	June 20	1	4	9	
105	Ona	p	1894	" 7	" 3	" 20	2	2	10	
106	Orange Co.	p	1895	" 7	" 1	" 22	4		7	1/5
107	Oregon 273	b	1894	" 11				3	6	
108	Orono	p	1895	" 5	June 11	June 16	1		8	1/5
109	Ostego	p	1894	" 12				2	9	
110	Pacific	p	1890	" 4	June 1	June 20	3	3	8	

TABULATION OF STRAWBERRIES.—Concluded.

Number.	Name.	Sex. b—bi-sexual. n—nearly. p—pistillate.	First planted.	First bloom.	First picking.	Last picking.	Productiveness. First crop—Scale (1-10).	Productiveness. Second crop—Scale (1-10).	Vigor of plant—Scale (1-10).	Weight of average berry in ounces.
111	Paris King	b	1895	May 8	June 3	June 16	2	----	9	⅕
112	Parker Earle	b	1889	" 7	" 5	" 20	5	2	7	----
113	Pawnee	p	1894	" 6	" 3	" 20	2	4	7	----
114	Phillip	b	1894	" 6	" 8	" 18	2	3	10	----
115	Price	b	1892	" 9	----	----	----	2	10	----
116	Primate	b	1894	" 6	June 1	June 20	2	4	6	----
117	Princess	p	1893	" 9	" 3	" 22	2	2	5	----
118	Princeton	b	1894	" 5	" 5	" 22	5	6	9	----
119	Puritan	n p	1887	----	----	----	----	1	----	----
120	Richmond	b	1894	May 7	June 5	June 22	2	7	8	----
121	Riehl 6	b	1893	" 4	" 1	" 22	5	3	8	----
122	Rio	b	1894	" 5	" 1	" 22	4	3	7	----
123	Robinson	b	1894	" 5	" 1	" 22	6	2	6	----
124	Sadie	p	1890	----	----	----	----	7	----	----
125	Sandoval	b	1890	May 5	June 3	June 22	3	3	6	----
126	Saunders	b	1889	" 11	" 1	" 22	6	6	10	----
127	Scarlet Ball	p	1892	" 7	" 7	" 22	6	3	7	----
128	Sharpless?	b	1880	" 9	" 9	" 22	4	----	9	----
129	Shawnee	n p	1894	" 7	" 3	" 22	7	5	10	----
130	Sherman	b	1895	" 7	" 5	" 22	2	----	6	1-5
131	Shuckless	b	1894	" 5	" 1	" 22	3	3	9	----
132	Smalley	p	1894	" 8	" 3	" 22	5	3	9	----
133	Smeltzer	b	1894	" 5	" 1	" 16	1	2	9	----
134	Smith	b	1894	" 5	" 1	" 16	4	3	10	----
135	Snowball	b	1895	" 5	" 3	" 22	3	----	9	⅓
136	Southard	b	1892	" 5	" 1	" 22	3	4	8	----
137	Speece	p	1890	" 9	" 3	" 22	4	2	6	----
138	Splendid	b	1893	" 4	" 1	" 20	5	4	8	----
139	Springdale	b	1894	" 8	" 5	" 20	3	3	7	----
140	Stahelin	p	1894	" 6	" 3	" 22	5	5	9	----
141	Standard	b	1894	" 4	" 3	" 20	4	3	8	----
142	Staples	b	1895	" 5	May 27	" 16	5	----	6	¼
143	Stewart	b	1895	" 4	" 27	" 16	3	----	9	1-5
144	Sunnyside	p	1895	" 8	June 3	" 22	4	----	9	⅕
145	Surprise	b	1893	" 6	" 3	" 22	3	2	6	----
146	Swindle	p	1893	" 6	" 3	" 22	6	3	7	----
147	Tennessee	b	1894	" 7	" 3	" 22	4	6	9	----
148	Thompson 40	p	1894	" 3	" 5	" 22	3	2	9	----
149	Thompson 66	p	1894	" 8	" 5	" 22	2	6	9	----
150	Timbrell	p	1893	" 12	" 15	" 22	1	3	6	----
151	Tom Walker	p	1894	" 12	" 5	" 22	1	2	8	----
152	Tonga	p	1894	" 6	" 8	" 22	3	3	9	----
153	Topeka	b	1894	" 7	" 5	" 27	3	3	9	----
154	Van Deman	b	1894	" 4	" 3	" 11	2	----	8	----
155	Warfield	p	1890	" 5	" 1	" 18	7	7	9	----
156	Weston	p	1893	" 6	" 3	" 20	2	3	6	----
157	Williams	b	1892	" 11	" 3	" 22	3	3	9	----
158	Wilson	b	1876	" 5	" 3	" 22	3	2	9	----
159	Wood (Beder)	b	1890	Apr. 30	" 1	" 22	7	3	10	----
160	Woolverton	b	1891	May 11	" 3	" 23	5	9	9	----
161	Wyatt	b	1895	" 7	" 8	" 22	2	----	6	1-5

As will be obvious from the foregoing table, owing doubtless to the peculiarities of the season, combined with unfavorable environment otherwise, few if any of the varieties under trial can be assumed to have shown their inherent capabilities. Indeed, while thirty-six, of the tabulated varieties have reached the assumed medium in one or the other of the plats compared, only nine of these have reached such medium in both plats; while a single one only—the Charlie—has reached the maximum in either plat.

Under these circumstances descriptions would doubtless be liable to prove misleading. It is therefore thought better to omit them this year.

RASPBERRIES.—(*Rubus*).

The old plat of small fruits was fruited, this year, for the last time, and has now been removed.

The new plat, planted in the spring of last year, owing doubtless in a large measure to the severe drouths of last season and that of the past spring, even next year, will scarcely yet be in condition to fully express the relative characteristics of varieties.

The difficulty of making early and trustworthy comparisons, in cases of newly introduced varieties, is frequently increased by the custom of many introducers of supplying less than a stand (often only one, two or three plants), of varieties for trial, necessitating more or less enfeeblement of those received, as the result of propagation for the completion of the stand of ten plants from which, in all cases, comparisons are drawn.

Between April 11th and 13th both the old and the new plantations of raspberries (including blackberries also), were sprayed with a solution of a pound of copper sulphate in twenty-five gallons of water.

As a preventive of anthracnose, the raspberry and blackberry plats were again sprayed, on May 16th, with Bordeaux mixture of standard strength.

On June 10th raspberries and blackberries were again sprayed for anthracnose, using a solution of three ounces of copper sulphate in fifty gallons of water. These two sprays have apparently proved quite effectual, since very little of the fungus is now (Oct.) perceptible.

Insects have not, this year, proved troublesome upon the raspberry, although occasional deposits occur of the eggs of the snowy cricket—*Œcanthus niveus*.

As in my previous report, the comparison of values is by the weight of a specimen instead of size.

Productiveness and quality are expressed upon the scale 1 to 10—the latter being the maximum.

RASPBERRIES (*Rubus*).

Number.	Name.	Species.	Planted.	First bloom.	First picking.	Last picking.	Weight of berry in ounces.	Productiveness—Scale (1-10).	Color. b—black. r—red. y—yellow.	Quality—Scale (1-10).
1	Ada	Occidentalis	1890	May 18	June 20	July 20	1-14	4	b	4
2	American Everbearing	Occidentalis	1893	" 13	" 18	" 10	1-25	7	b	4
3	Brandywine	Strigosus	1888	June 2	" 30	Aug. 1	1-14	6	r	8
4	Cardinal	Neglectus	1890	May 20	" 20	July 29	1-7	7	r	5
5	Carman	Occidentalis	1890	" 13	July 8	Aug. 8	1-17	10	b	10
6	Caroline	Neglectus ?	1888	" 16	June 22	" 1	1-10	9	y	8
7	Centennial	Occidentalis	1888	" 15	" 18	July 8	1-10	10	b	4
8	Champlain	Idaeus ?	1895	----	----	----	----	----	----	----
9	Church	Strigosus	1894	May 14	June 20	Aug. 10	1-14	6	r	9
10	Columbian	Neglectus ?	1896	----	----	----	----	----	----	----
11	Conrath	Occidentalis	1893	May 14	June 22	July 15	1-9	6	b	5
12	Cromwell	Occidentalis	1889	" 12	" 16	" 10	1-15	10	b	5
13	Cuthbert	Strigosus	1888	" 20	" 22	" 29	1-10	5	r	5
14	Diamond	Occidentalis	1896	----	----	----	----	----	----	----
15	Doolittle	Occidentalis	1888	May 14	June 19	July 10	1-10	10	b	7
16	Earhart	Occidentalis	1888	" 13	" 19	Aug. 1	1-10	6	b	7
17	Early King	Strigosus	1894	" 19	" 17	July 29	1-8	8	r	9
18	Emmett	----	1895	" 27	" 25	" 29	1-10	6	r	5
19	Eureka	Occidentalis	1895	" 12	" 21	" 15	1-13	9	b	6
20	Farnsworth	Occidentalis	1891	" 16	" 22	" 16	1-20	7	b	4
21	Gault	Occidentalis	1895	----	----	----	----	----	----	----
22	Gladstone	Strigosus	1893	May 14	June 15	July 29	1-16	7	r	4
23	Golden Queen	Strigosus	1888	" 14	" 15	Aug. 1	1-12	8	y	7
24	Green (new)	Occidentalis	1895	" 15	" 22	" 8	1-8	4	b	4
25	Gregg	Occidentalis	1888	" 16	" 23	" 12	1-18	4	b	4
26	Hansell	Strigosus	1888	" 14	" 13	" 10	1-12	10	r	5
27	Herstine	Idaeus	1888	" 20	" 22	" 10	1-10	4	r	10
28	Hilborn	Occidentalis	1888	" 16	" 15	July 15	1-13	6	b	10
29	Idaho	Leucodermis	1890	" 16	" 29	" 8	1-8	4	b	5
30	Indiana	Occidentalis	1888	" 13	" 18	" 12	1-12	9	b	5
31	Jap. Wineberry	Phœnicolasius	1892	June 7	Aug. 7	Aug. 29	----	8	r	1
32	Johnston	Occidentalis	1888	May 16	June 23	July 15	1-24	10	b	4
33	Kansas	Occidentalis	1892	" 14	" 27	" 12	1-12	9	b	4
34	Kenyon	Strigosus	1895	" 20	" 21	Aug. 10	1-14	6	r	8
35	Logan (berry)	----	1896	----	----	----	----	----	----	----
36	Loudon	Strigosus	1895	May 21	June 23	Aug. 1	1-5	5	r	8
37	Lovett	Occidentalis	1891	" 14	" 20	July 10	1-14	10	b	10
38	Marlboro	Str. X Idaeus	1888	" 15	" 18	" 29	1-8	10	r	4
39	Miller	Strigosus	1895	" 22	" 22	Aug. 10	1-18	5	r	8
40	Mills (15)	Occidentalis	1895	" 19	" 23	July 12	1-16	4	b	6
41	Muskingum	Neglectus	1893	" 20	" 23	" 29	1-12	10	r	5
42	Nemaha	Occidentalis	1888	" 14	----	----	----	----	b	----
43	Ohio	Occidentalis	1888	" 13	June 18	July 15	1-12	10	b	6
44	Older	Occidentalis	1893	" 14	" 23	" 15	1-13	6	b	5
45	Palmer	Occidentalis	1890	" 11	" 16	" 8	1-14	10	b	8
46	Phœnix	Strigosus ?	1896	----	----	----	----	----	----	----
47	Progress	Occidentalis	1890	May 13	June 17	July 12	1-13	10	b	5
48	Redfield	Occidentalis	1895	" 27	" 26	" 29	1-20	6	b	5
49	Reeder	Strigosus	1888	" 16	" 17	Aug. 8	1-9	5	r	9
50	Reliance	Strigosus	1888	" 21	" 29	" 8	1-10	6	r	4
51	Shaffer	Neglectus	1888	" 20	" 20	July 29	1-10	4	r	5
52	Smith Giant	Occidentalis	1892	----	----	----	----	----	----	----
53	Smith Prolific	Occidentalis	1893	May 16	June 21	July 12	1-12	7	b	10
54	Souhegan	Occidentalis	1888	" 14	" 17	" 8	1-14	9	b	5
55	Superlative	Idaeus ?	1895	" 19	" 20	Aug. 15	1-12	5	r	4
56	Thompson	Strigosus	1890	" 18	" 15	July 29	1-12	6	r	4
57	Thwack	Strigosus	1895	" 16	" 20	Aug. 15	1-14	5	r	5
58	Turner	Strigosus	1888	" 23	" 22	" 10	1-21	6	r	10
59	Tyler	Occidentalis	1888	" 13	" 17	" 1	1-16	10	b	4
60	Winona	Occidentalis	1895	" 14	" 18	" 8	1-16	9	b	3

Ada and American Everbearing blackcaps, thus far, have exhibited no especially valuable qualities. The latter here develops no everbearing tendencies.

Conrath, Cromwell, Doolittle, Souhegan and Tyler are all early, and in most respects much alike. Doolittle is variable; and, in favorable seasons, occasionally of superior size and flavor. Souhegan and Tyler, though doubtless of separate origin, are practically identical.

Earhart is thus far the only blackcap tested here that can be said to be everbearing; producing, as it does, a fall crop upon the canes of the current year's growth; which, however, are not unfrequently caught by early frost in an unripe condition. Desirable only for the home plantation.

Palmer, so far, is scarcely excelled as a profitable second early blackcap.

Gregg and Nemaha, so long the leading market blackcaps, appear to be rapidly giving place to more recent varieties.

Cuthbert is still popular for market, and Golden Queen and Reeder can be safely recommended for the home plantation.

Early King, first planted in the spring of 1894, has so far proved productive of good size and fair quality. A promising red variety.

Herstine, though needing protection in winter, is well worth a place in the home plantation.

Thwack, red, was tested here more than a dozen years since, and condemned as too low in quality. An objection which is also, to some extent, true of Marlboro. Quite recently the former is being commended as an attractive market berry.

Notices of other recently tested varieties are deferred to await experience under more favorable conditions.

BLACKBERRIES.—(*Rubus villosus*).

The former plantation of blackberries has been uprooted since gathering the current year's crop.

Both the old and the new plantations were alternated with raspberries, as a safeguard against mixing varieties by means of sprouts or suckers. The two have, for this reason, been treated alike so far as spraying is concerned; and the reader is therefore referred for this to the section on raspberries.

Anthracnose has been the only troublesome fungus during the season; but the treatment described under the head of raspberries has apparently very nearly subdued it.

A few cases of red rust were discovered, and the plants were at once dug and burned; since which no farther cases have been discovered.

Of insects, the leaf miner, *Tischeria malifoliella*, Clemens, has been increasingly prevalent. The process of gathering and burning the affected foliage has again been resorted to. Later, their work has again become apparent; and the gathering and burning process has been repeated. Results, so far, indicate that a more effective process is needful for their extermination. With the above exception, insect pests have not proved troublesome during the season. Warm weather during the early part of the season shortened the fruiting season of some varieties, limiting both size and quantity of the fruit, though timely rain somewhat revived others, continuing their season and increasing their yield of fruit.

BLACKBERRIES (*Rubus villosus.*)

Number.	Name.	Planted.	First bloom.	First picking.	Last picking.	Weight of berry in ounces.	Productiveness—scale 1 to 10.	Quality—scale 1 to 10.
1	Agawam	1888	May	Ju	Aug.	1-5	7	8
2	Ancient Briton	1888	"	" 4.	" 5.	1-6	5	3
3	Austin							
4	Childs (Tree)	1888	June 1.	July 18.	Aug. 21.	1-10	6	5
5	Early Harvest	1888	May 20.	June 28.	" 1.	1-9	6	5
6	Early King	1890	" 16.	" 28.	" 1.	1-9	10	7
7	Early Mammoth	1888	" 15.	July 1.	" 1.	1-5	10	7
8	Eldorado	1894	" 15.	" 8.	" 4.	1-7	5	6
9	Erie	1888	" 15.	" 8.	" 7.	1-5	10	5
10	Fruitland	1893	" 22.	" 28.	" 1.	1-8	5	5
11	Kittatinny	1888	" 18.	" 8.	" 10.	1-6	10	7
12	Knox	1888	" 16.	" 7.	" 4.	1-6	8	7
13	Lawton	1888	" 16.	" 3.	" 1.	1-6	10	7
14	Lincoln	1893	" 14.	" 6.	" 1.	1-9	6	5
15	Lovett (Best)	1896						
16	Maxwell	1894	May 22.	July 8.	Aug. 5.	1-12	5	6
17	Minnewaski	1888	" 18.	" 16.	" 1.	1-5	10	5
18	Nevada	1888	" 18.	" 20.	" 15.	1-5	7	5
19	Ohmer	1893	" 18.	" 8.	" 1.	1-8	7	7
20	Oregon (Everbearing)	1893	June 7.	" 25.	" 21.	1-12	4	4
21	Otis	1896						
22	Piasa	1895	May 18.	July 9.	Aug. 6.	1-15	3	6
23	Reyner	1896						
24	Sanford	1894	May 15.	July 10.	Aug. 1.	1-9	10	5
25	Snyder	1888	" 13.	" 3.	" 1.	1-10	10	10
26	Taylor	1888	" 15.	" 8.	" 8.	1-11	8	10
27	Thompson	1888	" 18.	" 3.	" 18.	1-5	10	4
28	Triumph (Western)	1888	" 15.	" 7.	" 5.	1-8	10	4
29	Wallace	1888	" 14.	" 6.	" 1.	1-8	10	7
30	Wilson	1888	" 18.	" 2.	" 15.	1-4	8	4
31	Wilson, Jr.	1888	" 18.	" 2.	" 15.	1-5	6	4

NOTES ON VARIETIES.

Agawam, Knox, and Wallace are old varieties, which may be safely commended for home use, if not even for market.

Ancient Briton and Triumph (Western) are, in certain localities, commended for market. Though hardy, they are quite too small, unless with good soil, high culture and close pruning.

Austin, a new dewberry from Texas, Lovett (Best), Otis, and Reyner, are recently planted varieties not yet fruited.

Childs (Tree), though planted in 1888, has little so far to recommend it.

Early Harvest, though early and good, is rather small and lacks hardiness.

Early King and Early Mammoth are large, vigorous and productive They are worthy of extensive trial.

Eldorado, Fruitland, Lincoln, Maxwell, Ohmer, Piasa, and Sandford, though several of them appear to be promising, are yet on probation.

Erie, Minnewaski, Nevada and Thompson, so far appear to be variable; often more or less unproductive.

Snyder and Taylor are very hardy, of fair size, productive and profitable, where hardiness is specially needful.

Wilson, and Wilson, Jr., are practically identical, very large, of low quality, and the plants tender, requiring winter protection, even at the lake shore.

SERVICE BERRY (*Amelanchier*).

This fruit, under the name of June Berry, or Shad Bush, is common in the forests of portions of Michigan, as a large shrub or small tree, frequently attaining the height of fifteen or even twenty feet. The fruit is usually sparsely produced and variable in size, but generally small and of indifferent though pleasant quality.

The varieties grown here are understood to be of western origin, and are of dwarfish habit, usually three or four feet in height, aud producing abundant crops of fruit, in appearance much like the whortleberry, though by no means its equal in flavor.

These were received, the first as Dwarf June Berry, the second as Success, and the third as Mammoth. This last is slightly more vigorous than the others, and in occasional seasons perhaps a little more prolific; but the birds seem especially fond of the fruit, and are quite sure to appropriate it unless protected by netting.

CURRANTS.—*Ribes*.

A new stand of currants having been planted last year, the old plantation was uprooted, after securing the current year's crop.

March 30. Sprayed currants (in connection with gooseberries), with a solution of one pound of copper sulphate in 25 gallons of water.

April 30. Sprayed currants and gooseberries, to prevent mildew, using one pound copper sulphate in 500 gallons of water.

May 6. The currant worm, *Nematus ventricosus*, having appeared, both currants and gooseberries were sprayed with one pound of Paris green in 250 gallons of water.

May 15. To subdue the currant worm and mildew, currants and gooseberries were again sprayed, using Bordeaux mixture of standard strength, with the addition of ¼ pound of Paris green to 50 gallons.

June 1. Currants and gooseberries were again sprayed, for worms and mildew, using three ounces of copper sulphate and three ounces of Paris green in 50 gallons of water.

June 10. Repeated the spray upon currants and gooseberries, for worms and mildew, using the same preparation.

June 18. Sprayed gooseberries for mildew, using three ounces of liver of sulphur, *potassium sulphide*, in ten gallons of water.

July 10. Gooseberries were sprayed for mildew, with one pound of copper sulphate in 250 gallons of water.

August 4. Sprayed currants and gooseberries for mildew, with one pound of copper sulphate in 200 gallons of water.

More or less mildew has appeared upon several varieties of gooseberries of European parentage, due, probably to too long periods between sprayings, which were, in several cases, deferred on account of the prevalence of rain or high winds.

The twig borer, *Ægeria tipuliformis*, has apparently been less prevalent than heretofore, although the extent of its depredations may become more fully manifest during next spring's pruning.

Aside from those mentioned, no other insects have proved troublesome.

The weights of single berries are given instead of size, and it will be observed that, in all cases, the denominator of the fraction expresses the number of berries in an ounce.

Productiveness and quality are expressed upon the scale of one to ten, ten being in all cases the maximum, and each variety is compared with others of the same species.

CURRANTS.—(*Ribes.*)

Number.	Name.	Species.	Planted.	Bloomed.	Ripened.	Weight of berry in ounces.	Productiveness—scale (1-10).	Quality—scale (1-10).
1	Champion	Nigrum	1889	Apr. 24	June 20	1-17	5	5
2	Cherry	Rubrum	1888	" 21	" 15	1-28	5	7
3	Crandall	Aureum	1889	" 27	" 24	1-20	10	1
4	English	Nigrum	1892	" 28	" 15	1-18	10	5
5	Fay	Rubrum	1889	" 21	" 20	1-37	10	7
6	Holland (Long Bunched)	Rubrum	1889	" 27	" 20	1-44	10	5
7	Lakewood	Rubrum	1890	" 28	" 15	1-25	7	7
8	Lee	Nigrum	1888	" 25	" 20	1-21	5	8
9	London	Rubrum	1890	" 27	" 15	1-37	10	4
10	Naples	Nigrum	1888	" 28	" 20	1-37	1	5
11	North Star	Rubrum	1890	" 21	" 15	1-45	9	7
12	Red Dutch	Rubrum	1888	" 23	" 15	1-48	10	8
13	Ruby Castle	Rubrum	1892	" 24	" 15	1-45	7	6
14	Ruby (Moore)	Rubrum	1890	" 24	" 8	1-38	10	8
15	Saunders	Nigrum	1890	" 28	" 8	1-28	5	8
16	Select (Moore)	Rubrum	1890	" 21	" 15	1-35	7	5
17	Versaillaise	Rubrum	1888	" 21	" 15	1-39	10	7
18	Victoria	Rubrum	1888	" 27	" 15	1-41	10	5
19	Wales (Prince)	Nigrum	1890	" 27	" 20	1-15	9	8
20	White Dutch	Rubrum	1888	" 23	" 15	1-44	10	10
21	White Gondoin	Rubrum	1890	" 27	" 15	1-30	10	10
22	White Grape	Rubrum	1888	" 27	" 15	1-33	10	8
23	Wilder	Rubrum	1890	" 28	" 8	1-20	10	7

NOTES ON VARIETIES.

Champion, Lee, Saunders and Wales are comparatively recent varieties of the European black currant, and the (Black) English is a much older one of that species. So far, none of these, here, have equaled the Naples, in either vigor or productiveness; neither have they excelled it in size of fruit.

Cherry, Fay, Wilder and Lakewood are quite similar in foliage and size of fruit. In productiveness they range about in the order named.

Crandall, a variety of the yellow flowering currant, betrays, in the diverse habit and productiveness of the plants, the probability, not to say certainty,

that it may have been the product, not of a single seedling, but rather of a batch of seedlings. It has been dropped from the collection here as unworthy.

Holland (Long-bunched), proves to be by far the most vigorous variety so far tested here. The bunches are long but the berries small. The size and productiveness of the plant, however, fully compensate for the lack of size of the fruit.

London (Red), though scarcely up in quality, is very vigorous and productive.

North Star is much like Holland in some respects, though scarcely as vigorous or productive so far.

Red Dutch is, even yet, scarcely excelled as a profitable market variety, with only the objection of its liability to the attacks of the twig borer, which, judging from experience here, so far, may, perhaps, be subdued by the persistent cutting and burning of the affected wood.

Ruby Castle, Ruby (Moore), and Select (Moore), appear to be desirable, if at all, rather as specialties for amateurs.

Victoria, apparently owes its popularity to a comparative exemption from the attacks of the twig borer and to the persistence of its foliage rather than to any superiority otherwise.

White Dutch and White Gondoin are much alike, and may fairly be said to have no superiors, especially so far as great beauty and high quality are concerned.

White Grape, though scarcely equal to the foregoing in quality, and notwithstanding its faulty habit of growth, is slightly larger in berry, and, possibly, somewhat more productive.

GOOSEBERRY.—(*Ribes*).

Gooseberries are grown in rows adjacent to currants, and, so far as spraying is concerned, the two have received the same treatment, for which reference is made to the section on currants.

It should be stated, however, as was remarked under the head of currants, that considerable mildew appeared upon certain varieties of gooseberries, notwithstanding the fungicide with which they were treated. This may have been due to delays in the application, on account of rains and high winds, or possibly to weather specially favorable to the growth of fungi.

The crumpling of the terminal foliage of certain varieties, believed to be due to the presence of minute aphides, has been less noticeable than in previous years.

The only other insect depredation observed has been that of the currant worm (*Nematus ventricosus*), also mentioned under the head of currants.

Necessarily, more or less small, weak plants were used in making the new plantation of gooseberries last year, and, of several scarce varieties, the stand is even yet not full. Such being the case, at least a year or two must necessarily elapse before such plants can be expected to yield competent returns for purposes of comparison.

GOOSEBERRIES.—(*Ribes.*)

Number.	Name.	Species.	Planted.	Bloomed.	Ripened.	Weight of berry in ounces.	Productiveness—scale (1 to 10.)	Quality—scale (1 to 10.)
1	Apex	Cynosbati	1893	Apr. 28	July 6	1-4	10	8
2	Auburn	Grossularia	1890	" 28	" 30	1-10	3	8
3	Bendelon	Grossularia	1894	" 30	" 30	1-4	6	8
4	Champion	Grossularia	1891	" 27	" 29	1-10	5	5
5	Chautauqua	Cynosbati	1893	" 28	" 29	1-4	7	9
6	Columbus	Grossularia	1895	" 29				
7	Downing	Cynosbati	1883	" 27	July 28	1-8	7	6
8	Golden (Prolific)	Grossularia	1891	" 30				
9	Houghton	Hirtellum	1888	" 27	July 30	1-13	5	10
10	Industry	Grossularia	1889	" 25	" 27	1-3	10	7
11	Keepsake	Grossularia	1894	" 28	" 30	1-6	1	9
12	Lancashire (Lad)	Grossularia	1894	" 28	" 30	1-4	2	10
13	Orange (Early)	Grossularia	1890	" 27	" 20	1-5	2	8
14	Pale Red	Hirtellum	1890	" 27	" 30	1-13	7	10
15	Pearl	Grossularia	1890	" 27	" 28	1-7	7	10
16	Red Jacket	Grossularia	1890	" 27	" 30	1-4	1	8
17	Smith	Cynosbati	1888	" 27	" 26	1-10	6	10
18	Strubler	Cynosbati	1892	" 28	" 27	1-5	1	8
19	Tree	Cynosbati	1892	" 28	" 6	1-14	1	5
20	Triumph	Grossularia	1890	" 25	" 27	1-4	10	7

Apex, having been transplanted last year, has not yet properly developed its vigor. The plant is much like the European; although it is understood to be a seedling of the indigenous Oregon species.

Auburn, Bendelon, Columbus, Golden (Prolific), Keepsake, Lancashire (Lad) and Orange (Early) are all either European varieties, or American seedlings of European parentage, not yet sufficiently tested at this station. If exempt from mildew in this climate, it will doubtless be under efficient treatment with fungicides.

Champion, Industry, Pearl and Triumph have, for a year or two, with free use of fungicides, proved fairly vigorous and productive. They appear to be worthy of trial; but only by those who will give them efficient treatment.

Chautauqua and Red Jacket are highly commended as vigorous and productive. Both are comparatively new here. The latter is very vigorous; but their productiveness is yet to be developed in this locality.

Downing, though not of high quality, is popular as a market variety. Smith would doubtless stand still higher for such purpose, but for lack of vigor.

Houghton and Pale Red are practically identical; of good quality, and very hardy and productive, but too small.

Strubler and Tree are native western seedlings, healthy and vigorous; productiveness yet to be determined; fruit small.

CHERRIES.—(*Prunus*).

Most varieties of cherries have borne rather lightly this season. This is especially true of those received as North German or Russian varieties; while the Duke and Mazzard or sweet varieties are yet scarcely old enough to be expected to fruit heavily.

The trees were yet dormant, on April 14, when they, in common with the entire plantation, received the spray of strong solution of copper sulphate.

Cherries have been exempt from the attacks of fungi; so that no farther applications of fungicides have proved needful.

June 11. The slug, *Eriocampa cerasi*, having made its appearance; the trees were treated with a spray consisting of a tablespoonful of buhach, in a gallon of water, which proved effective for the time. A new colony appearing, another spray was applied on the 15th to the 20th, consisting of a strong decoction of tobacco stems in water, which proved thoroughly effective.

The slug proving unusually persistent, the tobacco decoction was again applied on June 20; and, for yet another visitation on August 21.

Except as already specified, no insect attacks have been observed. The curculio which frequently visits the fruit, seems to have confined its depredations to the plums and early peaches.

Estimates of productiveness and quality, as given in the following table, apply strictly to the crop of the current year.

CHERRIES (*Prunus*).

Number.	Name.	Species.	Planted.	Bloomed.	Ripened.	Weight of berry in ounces.	Productiveness—scale 1 to 10.	Quality—scale 1 to 10.
1	Abbess	Morello	1888	April 27	June 15	1-8	4	5
2	Angouleme	Morello	1888	" 27	" 27	1-7	1	8
3	Badacconyi	Avium	1894	" 27				
4	Baendor	Morello	1892	" 28	June 8	1-8	2	5
5	Baltavari	Avium	1894					
6	Bessarabian	Morello	1888	April 27	" 17	1-5	3	6
7	Brusseler Braune	Morello	1888	" 28	July 2	1-4	5	8
8	Carnation	Duke	1891	" 27	June 8	1-6	7	7
9	Centennial	Avium	1893	" 29				
10	Choisy	Duke	1888	" 27	June 6	1-7	1	9
11	Cleveland	Avium	1888	" 24	" 5	1-6	7	8
12	Coe (Trans.)	Avium	1888	" 23	May 30	1-5	3	7
13	Dwarf Rocky Mountain		1894	May 4	July 20			
14	Dyehouse	Morello	1891	April 28	June 2	1-6	10	5
15	Eagle (Black)	Avium	1888	" 24	" 8	1-6	6	5
16	Early Purple	Avium	1892	" 20	" 1		7	
17	Elton	Avium	1892	" 28	" 6	1-5	5	5
18	Esperen	Morello	1892	" 25	" 6	1-7	3	6
19	Eugenie	Duke	1888	" 24	" 1	1-7	8	9
20	Everbearing	Morello	1892	" 27	" 8	1-6	4	8
21	Florence	Avium	1892	" 24	" 17	1-14	2	6
22	Frauendorfer Weichsel	Morello	1888	" 25	" 17	1-5	4	6
23	Galopin	Morello	1891	" 25	" 15	1-5	1	7
24	George Glass	Morello	1888	" 24	" 18	1-5	2	4
25	German (Kraus)	Avium	1894					
26	Griotte du Nord	Morello	1888	April 27	July 4	1-6	2	6
27	Hoke	Avium	1896					
28	Hortense	Duke	1888	April 27	June 8	1-7	9	
29	Ida	Avium	1893	" 25				
30	King Amarelle	Morello	1891	" 25	June 4	1-7	7	5
31	Knight Early	Avium	1891	" 25	" 8	1-7	4	10
32	La Maurie	Avium	1893					
33	Lancaster		1894					
34	Late Duke	Duke	1890	April 28	June 4	1-6	3	6
35	Lithauer Weichsel	Morello	1892	" 27	" 17	1-12	8	4
36	Luce (Gov.)		1896					
37	Lutovka	Morello	1888	April 28	" 25	1-6	3	7
38	Magnifique	Duke	1888	" 29	July 4	1-5	3	9
39	Mahaleb	Mahaleb	1893	" 30	" 21		3	
40	Mary (Kirtland)	Avium	1891	" 25	June 3	1-7	9	8
41	Mastodon (Black)	Avium	1893	" 27				
42	May Duke	Duke	1888	" 24	May 30	1-6	3	8
43	Mezel	Avium	1891	" 23	June 5	1-5	6	8
44	Minnesota (Ostheim)	Morello	1892	" 27	" 15	1-7	4	7
45	Modnyansky	Avium	1894	" 27				
46	Montmorency	Morello	1888	" 27	May 2	1-2	10	4
47	Montmorency, Ordinaire	Morello	1891	" 27	" 10	1-6	9	5
48	Montreuil	Duke	1890	" 19	" 2	1-4	10	6
49	Napoleon	Avium	1892	" 22	" 18	1-8	8	4
50	Northwest	Morello	1893	" 29	" 28	1-7	10	6
51	Ohio (Beauty)	Avium	1891	" 25	" 2	1-6	6	6
52	Olivet	Duke	1890	" 27	" 8	1-5	1	4
53	Orel 25	Morello	1893	" 28				
54	Orel 27	Morello	1893	" 29				
55	Ostheim	Morello	1891	" 27	May 15	1-16	3	4
56	Ostheimer	Morello	1893	" 29	" 25	1-9	7	4
57	Philippe (Louis)	Morello	1888	" 24	" 6	1-7	6	8
58	Plymouth Rock		1896					
59	Purity	Avium	1893					
60	Richmond	Morello	1892	April 24	May 8	1-7	7	4

CHERRIES (*Prunus*).—CONCLUDED.

Number.	Name.	Species.	Planted.	Bloomed.	Ripened.	Weight of berry in ounces.	Productiveness—scale 1 to 10.	Quality—scale 1 to 10.
61	Rockport	Avium	1891	April 24.	May 2.	1-6	9	4
62	Royal Duke	Duke	1891	" 25.	" 8.	1-4	4	[illegible]
63	Rupp	----	1894	----	----	----	----	----
64	Schmidt	Avium	1894	----	----	----	----	----
65	Sebril	----	1896	----	----	----	----	----
66	Sklanka	Morello	1888	April 27.	May 6.	1-8	9	4
67	Spanish (Yellow)	Avium	1891	" 24.	" 13.	1-4	4	10
68	Spate Amarelle	Morello	1888	" 28.	" 20.	1-6	3	[illegible]
69	Strauss Weichsel	Morello	1888	" 27.	" 6.	1-9	3	[illegible]
70	Suda	Morello	1893	" 29.	" 25.	1-8	10	[illegible]
71	Tartarian (Black)	Avium	1888	" 27.	" 6.	1-6	1	[illegible]
72	Ulatis (Cal. Adv.)	Avium	1893	" 27.	----	----	----	----
73	White (Bigarreau)	Avium	1896	----	----	----	----	----
74	Weir	Morello	1893	April 27.	June 6.	1-6	8	[illegible]
75	Windsor	Avium	1891	" 21.	" 8.	1-5	9	[illegible]
76	Wood (Gov.)	Avium	1891	" 24.	" 2.	1-6	9	[illegible]
77	Wragg	Morello	1892	" 26.	" 23.	1-8	9	4
78	Younoken (Golden)	----	1896	----	----	----	----	----

NOTES ON VARIETIES.

A few notices of the species, origin, etc., also of the sources whence received are appended.

Abbess, received from the Russian importation of Prof. J. L. Budd. sadly lacks vigor, and is, so far, only moderately productive.

Angouleme, from the same source, is unusually vigorous, but so far sadly deficient in productiveness.

Badacconyi, Baltavati and Modnyansky belong to the sweet or Mazzard class of cherries, and are very vigorous, with promise of early fruitfulness. They come from southeastern Europe, as an importation through the National Division of Pomology.

Baender, Esperen, Everbearing, Galopin, King Amarelle, Lithauer Weichsel, Minnesota (Ostheim), Northwest, Orel 25, Orel 27, Ostheim. Ostheimer, Suda, Weir and Wragg come from unknown sources, through the Michigan Agricultural College. They are all, or nearly all, of the Morello type. Several of them promise early and abundant productiveness, but, so far, there is much apparent similarity among very many of them.

Bessarabian, Brusseler Braune, Frauendorfer Weichsel, George Glass, Griotte du Nord, Lutovka, Sklanka, Spate Amarelle and Strauss Weichsel are from the Budd importation. All are vigorous, fairly productive. and (with the single exception of Sklanka), quite acid, and ripen late They are especially adapted to culinary purposes.

Carnation, Late Duke and Royal Duke are old varieties of the Duke class. They are apparently too persistently unproductive to ever become popular.

Centennial, La Maurie, Mastodon (Black), and Ulatis (California Advance), are understood to be California seedlings. Little is yet known of them at the east.

Choisy is one of the most beautiful and excellent of cherries, but only moderately productive. It is of the Duke class.

Cleveland, Mary (Kirtland), Ohio (Beauty), Purity, Rockport and Wood (Gov.), are Ohio seedlings, originated by the late Dr. Kirtland, of Cleveland. Several of them are more or less popular as market varieties.

Coe (Transparent), has long been recognized as one of the most beautiful and excellent of sweet cherries.

Dwarf Rocky Mountain is a recent introduction from the "wild and woolly west." If the plants on trial here correctly represent the variety. it is utterly worthless for any purpose.

Dyehouse is a very early and productive variety of the Morello class. The tree is a very slender, spreading grower, and the fruit is rather small.

Eagle (Black), Early Purple, Elton, Florence, Knight, Early Mezel, Napoleon, Spanish (Yellow) and Tartarian (Black), are all Mazzards, of European origin, but have long since acquired more or less popularity in this country.

Eugenie, Hortense, Magnifique, May Duke, Montrueil and Olivet are of the Duke class, imported from Europe. Several of them have long since become highly popular in this country.

German (Kraus), is a variety of the Mazzard class, received for trial from the State of New York.

Ida and Lancaster are Dukes, both of comparatively recent origin, in the State of Pennsylvania.

Hoke, Luce (Gov.), Plymouth Rock, Rupp and Sebril were received, last spring, from various sources. They require yet another season's growth to indicate even the species to which they belong.

Mahaleb, the European Bird Cherry, is rarely used otherwise than for stocks.

Montmorency and Montmorency Ordinaire are of the Morello type.

Montmorency Large, as received here, proved incorrect. The one named above as Montmorency may prove to be the Large.

Phillippe (Louis) is an excellent, large Morello, and the tree vigorous. but persistently unproductive.

Richmond is too well known as a leading market Morello to require further description.

Schmidt and White (Bigarreau) were received in cion from the National Division of Pomology, in 1895. They are vigorous growers of the Mazzard class.

Windsor is a recent seedling of the Mazzard type, originating at Windsor, Ont. (opposite Detroit). Season late. It is attracting much attention.

PEACHES.—(*Prunus*).

With peaches, as with other portions of the plantation, the needful pruning was done during intervals of mild weather, in February and March.

In common with the entire plantation, they were treated with a spray of strong copper sulphate (one pound in 25 gallons of water), on April 14 to 17, while growth was yet dormant.

This early treatment, so far as the peach was concerned, was mainly intended to act as a preventive of leaf curl, *Taphrina deformans*. Owing, doubtless, to the peculiarity of the season, this precautionary treatment was apparently unnecessary, since, without regard to spraying, the entire locality has been partially if not wholly exempt from this malady, this season.

In the absence of other attacks of fungi, no other applications of fungicides have been found necessary.

May 5, commenced examining peach trees to destroy such borers, *Ægeria exitiosa*, as had escaped detection during the examinations of last September. Finished such examination on the 12th, finding an occasional larva.

May 14, commenced jarring trees for curculio. Its depredations upon the peach were very slight; and, as usual, mainly confined to the early and comparatively smooth skinned varieties, while, even upon these, so few insects were caught that examinations were soon abandoned, so far as the peach was concerned, and, thereafter, the jarrings were confined to the plum.

Experience here quite clearly indicates the wisdom of planting plums and peaches adjacent, and using the former as a curculio trap.

The Rose Chafer, *Macrodactylus subspinosus* has been less troublesome than heretofore, only a very few having been discovered; an occasional one only upon the peach.

Within the last three or four years a new insect enemy has appeared in the peach orchards of this vicinity, attacking the trunks and larger branches of bearing trees. The eggs are deposited upon the bark and, when hatched, the larva pierces the wood, making channels through and through it, which, outwardly, appear as if occasioned by the firing of a charge of small shot, with very serious and ultimately fatal effect upon the vigor and health of the trees attacked. As soon as discovered, last year, a coating of soap, lime and a little carbolic acid was applied to the trunks and larger branches to prevent, as far as possible, the depositing of the eggs. The above mixture was again applied on May 20, 1896. A considerable number of the older and more enfeebled trees have already been dug and burned.

In this immediate vicinity the entire spring passed without adequate rainfall, and although there were a few slight showers during the early summer, no copious rains occurred here prior to the middle of July. The village water works became available on July 7, prior to which date much expense was necessarily incurred in hauling water from Lake Michigan, for use upon various crops including newly planted trees and others heavily laden with fruit. To derive full benefit from access to the village water mains some adequate arrangement for economical distribution is yet needed.

Most varieties of fruits sent to this station for trial come without history, description, or in fact any clue to aid in determining their genuineness. Cases indeed occasionally occur in which two trees, received from the same source, under the same name, prove to be of distinct varieties with no apparent means of determining which was the variety really intended.

In such cases a concise description of the variety intended should accompany the trees.

Productiveness and quality, as given in the following table, have reference strictly to the crop of the current year.

PEACHES.—(*Prunus.*)

Number.	Name.	Planted.	Bloomed.	Flowers—l, large; s, small.	Glands—g, globose; r, reniform; s, serrate.	Ripened.	Adhesion—c, cling; f, free; s, semi cling.	Weight of specimen in ounces.	Productiveness—scale (1-10).	Quality—scale (1-10).
1	Adrian	1892	Apr. 27	s	g	Sept. 15	f	4¾	4	6-7
2	Alberge	1893	" 27	s	r	Aug. 13	f	2½	5	6-7
3	Albright	1890	" 27	s	g	Sept. 11	f	4½	4	5-6
4	Alexander	1892	" 7	l	g	July 22	s	5¾	8	5
5	Allen	1890	" 27	s	r	Sept. 21	f	4½	10	5
6	Alpha	1890	" 27	s	r	Aug. 17	c	5¾	2	4
7	Amelia	1890	" 28	l	r	" 12	f	5	9	6-7
8	Amsden	1890	" 27	s	g	July 7	s	4	10	5
9	Andrews	1890	" 27	s	r	Sept. 10	f	5	3	5
10	Arctic	1894	" 25	l	r	" 24	s	2	1	3
11	Barber	1893	" 27	l	r	" 4	f	6¾	7	7
12	Beers (Smock)	1890	" 27	s	r	" 18	f	4½	8	5
13	Bell (Fav.)	1890	" 27	s	g	Aug. 31	s	5	7	4-5
14	Bequett (free)	1890	" 25	s	r	" 24	f	6½	10	5
15	Berenice	1894	" 27	?	r	Sept. 11	f	5	2	4
16	Bickell	1890	" 27	s	r	Sept. 28	f	3¾	3	1-2
17	Bishop	1890	" 27	s	g	Aug. 4	s	5	7	8
18	Blood Leaf	1892	" 25	l	r	Sept. 22	c	2¾	9	1
19	Bokhara	1896								
20	Bonanza	1890	Apr. 27	s	r	Sept. 28	f	3½	10	1-2
21	Boyle	1890	" 27	s	g	Aug. 17	f	4	6	7
22	Brandywine	1890	" 28	s	g	Sept. 14	f	6	6	5
23	Brett	1890	" 28	s	r	Oct. 13	c	3½	9	2
24	Brigdon	1890	" 27	s	g	Aug. 20	f	3¾	6	7-8
25	Briggs	1890	" 27	s	g	" 15	f	5¾	5	8
26	Bronson	1890	" 27	s	r	Sept. 1	f	3¾	8	6-7
27	Brown	1893	" 21	l	r	Aug. 10	f	4	8	4
28	Burke	1892	" 27	l	r	" 31	s	8	4	5
29	California	1895					r			
30	Canada	1892	Apr. 25	l	g	July 15	c	4	10	4
31	Capital	1896								
32	C—— Cling	1894			r					
33	Chairs	1890	Apr. 27	s	r	Sept. 15	f	4	8	3-4
34	Champion (Ohio)	1892	" 25	l	s	July 9	c	3	7	10
35	Champion (Mich.)	1890	" 25	s	g	Aug. 14	f	8	7	4
36	Chili	1888	" 27	l	r	Sept. 4	f	3½	9	5
37	Chili 2	1888	" 25	s	r	" 11	f	5	10	6-7
38	Chili 3	1888	" 27	s	r	" 7	f	5	7	8
39	Chinese (Cling)	1890	" 25	l	r	Apr. 24	c	3¾	2	6-7
40	Chinese 11741	1896								
41	Cleffey (Allen)	1893	Apr. 27	s	r	Aug. 31	f	5½	6	5
42	Clifton (Cling)	1896								
43	Columbia	1890	Apr. 27	l	r	Sept. 17	f	5	10	1-2
44	Conkling	1890	" 25	s	r	Aug. 24	f	4¾	7	4
45	Connecticut	1896								
46	Connett	1894	Apr. 27	?	r	Aug. 15	f	5¾	2	7-8
47	Coolidge (Mam.)	1892	" 25	s	g	Sept. 4	f	5	7	7
48	Corner	1890	" 27	s	r	Aug. 31	f	5	4	5-6
49	Crosby	1892	" 27	s	r	Sept. 15	f	4	8	7
50	Crothers	1890	" 25	s	g	" 10	f	5	9	6-7
51	Dennis	1890	" 25	l	g	Aug. 24	f	3½	10	4-5
52	Diamond	1892	" 27	s	g	Sept. 15	s	6	5	5
53	Druid Hill	1890	" 27	s	g	" 16	f	5	8	8
54	Dumont	1894	" 27	s	r	Aug. 25	f	4	2	3-4
55	Dunlap	1893	" 27	s	g	" 24	f	4¾	5	7-8

PEACHES.—CONTINUED.

Number.	Name.	Planted.	Bloomed.	Flowers—l, large; s, small.	Glands—g, globose; r, reniform; s, serrate.	Ripened.	Adhesion—c, cling; f, free; s, semi cling.	Weight of specimen in ounces.	Productiveness—scale (1-10).	Quality—scale (1-10).
56	Dwarf Cuba	1892	Apr. 27	s	r	Sept. 19	c	5	1	1-3
57	Early Barnard	1888	" 27	s	r	Aug. 20	f	3¾	9	5
58	Early Crawford	1888	" 27	s	g	" 8	f	5	8	8
59	Early Crawford 1	1888	" 27	s	g	" 12	f	4½	10	7-8
60	Early Crawford 3	1888	" 27	s	g	" 19	f	4½	9	7
61	Early Michigan 15	1894	" 25	l	g	" 13	f	3	6	9-10
62	Early Michigan 16	1892	" 25	l	r	" 8	f	4	10	9-10
63	Early Silver	1888	" 27	l	r	" 21	f	2¾	10	5
64	Ede	1890	" 25	s	g	" 28	f	5	7	6
65	Elberta	1890	" 27	s	r	" 31	f	4	8	5-6
66	Eldred (Cling)	1890	" 27	s	g	" 17	c	6	-----	-----
67	Ellison	1889	" 27	s	r	Sept. 24	f	3	7	4-5
68	Engle (Mam.)	1892	" 25	s	g	Aug. 20	f	5	7	9-10
69	Ford New	1894	" 27	s	g	" 31	f	6	8	6
70	Ford Red	1894	" 27	s	g	-----	-----	-----	-----	-----
71	Ford 1	1894	" 27	s	r	Aug. 10	f	6¾	4	6-7
72	Ford 2	1894	" 27	s	g	Sept. 20	f	6	1	6-7
73	Ford 3	1894	" 28	s	r	-----	-----	-----	1	-----
74	Foster	1888	" 27	s	g	Aug. 10	f	5¾	8	7-8
75	Fox	1890	" 27	s	g	Sept. 11	f	3¾	7	6
76	Geary (Hold on)	1890	" 27	s	r	" 17	f	6	10	6
77	Gem (Cling)	1890	" 27	s	r	" 8	c	4	7	5
78	Globe	1888	" 27	s	g	Aug. 13	f	5¾	5	5
79	Gold Drop	1890	" 25	l	r	Sept. 8	f	2½	7	6-7
80	Grant (Gen.)	1890	" 27	s	r	" 14	c	4½	5	3-4
81	Great Western	1892	" 27	s	r	Aug. 2	c	4¾	4	4
82	Greensboro	1896	-----	-----	-----	-----	-----	-----	-----	-----
83	Gudgeon	1890	Apr. 27	s	r	Sept. 17	f	5	5	4-5
84	Haas	1890	" 27	l	r	July 29	f	3½	10	6
85	Hale	1888	" 25	l	g	" 30	s	4	10	5
86	Hale Oblong	1888	" 25	l	g	" 27	s	6	9	3-4
87	Hance Golden	1890	" 27	s	g	Aug. 19	f	4½	8	8-9
88	Hance Smock	1890	" 27	s	r	Sept. 27	f	4	9	4-5
89	Heath Cling	1890	" 27	s	r	" 28	c	6¾	4	7-8
90	Hughes IXL	1892	" 25	l	r	-----	-----	-----	-----	-----
91	Husted 101	1895	" 27	s	r	-----	-----	-----	-----	-----
92	Husted 180	1895	-----	-----	r	-----	-----	-----	-----	-----
93	Husted 700	1895	Apr. 27	-----	g	-----	-----	-----	-----	-----
94	Hyatt	1888	" 27	l	g	July 28	s	4	7	7
95	Hynes (Sur.)	1890	" 27	l	g	" 30	s	3	8	5
96	Hyslop	1892	" 27	s	r	Sept. 22	c	5¾	8	4
97	Ice Mountain	1894	" 27	l	r	Nov.	-----	-----	-----	-----
98	Infant Wonder	1892	" 25	s	g	Aug. 24	f	-----	-----	-----
99	Ingold	1892	-----	-----	-----	-----	-----	-----	-----	-----
100	Iron Mountain	1895	Apr. 27	s	r	Oct. 1	f	5½	1	1
101	Jacques	-----	-----	-----	-----	-----	-----	-----	-----	-----
102	Jacques Late	1890	Apr. 27	s	g	Sept. 8	f	4	6	-----
103	Japan Dwarf	1894	" 27	l	r	July 27	f	3½	6	5
104	Jersey Yellow	1895	-----	-----	-----	-----	-----	-----	-----	-----
105	Jones	1892	Apr. 27	s	g	Sept. 10	s	6	3	5-6
106	June Rose	1890	" 23	l	g	Aug. 19	f	4¾	10	6-7
107	Juno	1894	" 27	-----	r	-----	-----	-----	-----	-----
108	Kalamazoo	1890	" 27	s	r	Aug. 31	f	3¾	9	7-8
109	Kallola	1892	" 25	l	r	Sept. 7	f	4½	10	3-4
110	Kraus 4	1896	-----	-----	-----	-----	-----	-----	-----	-----

PEACHES.—CONTINUED.

Number.	Name.	Planted.	Bloomed.	Flowers—l, large; s, small.	Glands—g, globose; r, reniform; s, serrate.	Ripened.	Adhesion—f, free; s, semi cling; c, cling.	Weight of specimen in ounces.	Productiveness—scale (1-10).	Quality—scale (1-10).
111	Kraus 16	1896								
112	La Fleur	1895	Apr. 25	l	r	Sept. 24	f	2	1	2-3
113	Lancaster	1894								
114	Late Barnard	1892	Apr. 27	s	r	Sept. 4	f	4	4	5-6
115	Late White	1889	" 27	s	r	" 14	f	4¾	6	5
116	Lemon Cling	1888	" 27	s	g	Aug. 24	c	5½	8	6-7
117	Lemon Free	1894	" 27	l	r	Sept. 26	f	6	3	4
118	Lewis	1890	" 27	l	r	Aug. 4	f	7	6	7
119	Lock Cling	1892	" 27	s	g	Aug. 24	c	5½	8	6-7
120	Longhurst	1894	" 27	s	g	Sept. 21	f	3	1	3
121	Lorentz	1895	" 27	s	r					
122	Lovell	1892	" 24	s	g	Sept. 9	f	4	8	7-8
123	Lovett White	1892	" 27	s	r	" 10	f	4½	10	6-7
124	Magdala	1890	" 27	s	r	" 18	f	3½	10	4-4
125	Mammoth Heath	1892	" 25	l	r	" 18	c	4	8	3-4
126	Marshall	1890	" 27	s	r	" 18	f	3½	10	4-5
127	McCollister	1892	" 24	s	r	" 18	f	5¾	9	6
128	McKevitt	1892	" 27	s	g	" 23	c	6½	1	3-4
129	Milhiser	1892	" 27	s	g	" 26	f	3¼	1	6
130	Minerva	1896								
131	Minnie (Texas)	1890	Apr. 27	s	r	Aug. 13	f	4¾	10	5-6
132	Minnie (College)	1892	" 28	s	r	Sept. 28	f	6	1	4
133	Moore	1890	" 27	s	g	Aug. 27	f	3¾	8	7-8
134	Morris Co.	1890	" 27	s	r	Sept. 21	f	4	9	3-4
135	Morris White	1888	" 27	s	r	Aug. 31	f	4½	6	9
136	Mountain Rose	1888	" 25	s	g	" 10	f	4	10	8
137	Muir	1890	" 27	s	r	Sept. 4	f	5¾	9	5-6
138	Murat	1889	" 27	s	r	" 15	f	5	7	5-6
139	Mystery	1888	" 27	s	r	Aug. 10	f	4½	10	8
140	N. Am. Apt.	1892	" 27	l	r	Sept. 7	f	3½	9	5-6
141	Nectarine	1889	" 27	l	r	" 11	f	3½	10	5
142	Need	1890	" 27	s	r	Aug. 19	f	4½	6	5
143	Neil (Marshall)	1892	" 22	l	r	Sept. 23	f	5	3	4-5
144	Newington (free)	1893	" 27	s	r	" 24	f	4½	3	6
145	New Prolific	1894	" 27	s	g	" 5	f	5	1	7
146	Normand	1892	" 27	s	r	Oct. 1	c	4½	3	5
147	Oldmixon (cling)	1888	" 27	s	g	Aug. 31	c	4	9	5
148	Oldmixon (free)	1893	" 27	s	g	Sept. 10	f	6	5	9-10
149	Oriole	1894	" 27	?	r	" 14	s	4	1	4
150	Oscar	1894								
151	Ostrander	1892	Apr. 25	s	g	Aug. 10	f	4½	7	8
152	Pallas	1894	" 27	l	g					
153	Palmerston	1890	" 27	l	g	Sept. 3	f	7	6	7
154	Pansy	1890	" 25	s	r	Aug. 5	f	5	6	4
155	Pearl	1889	" 27	s	g	Sept. 4	f	4	9	7
156	Peninsular Yellow	1894	" 27	s	g	" 11	f	4	1	4-5
157	Pickett	1890	" 27	s	r	" 17	c	5½	5	5-6
158	Pratt	1890	" 27	s	r	Aug. 17	f	4	5	6
159	Prince (Rareripe)	1890	" 25	s	g	" 24	f	4½	7	7-8
160	Princess	1894	" 27	l	g	Sept. 20		5½	1	8-9
161	Princess (Wales)	1889	" 27	l	g	" 7	f	4	9	7
162	Prize	1892	" 25	s	g	" 14	f	5½	8	5-6
163	Prize 1	1890	" 27	s	r	" 3	f	4	6	4-5
164	Red Cheek (Mel.)	1893	" 27	s	g	" 4	f	4½	5	5
165	Red Seedling	1893	" 25	l	g	Aug. 7	f	4	8	6

PEACHES.—CONCLUDED.

Number.	Name.	Planted.	Bloomed.	Flowers—l, large; s, small.	Glands—g, globose; r, reniform; s, serrate.	Ripened.	Adhesion—c, cling; f, free; s, semi-cling.	Weight of specimen in ounces.	Productiveness—scale (1-10).	Quality—scale (1-10).
166	Reed	1890	Apr. 25	s	g	Aug. 17	f	5¾	5	6-7
167	Reeves (Fav.)	1890	" 27	s	g	" 24	f	6	7	6-7
168	Ringold	1890	" 27	s	r	Sept. 18	c	4½	6	6-7
169	River Bank	1892	" 27	l	r	July 13	s	5	8	5
170	Rivers	1888	" 27	l	r	" 28	s	5½	10	7
171	Robena	1894	-----	-----	-----	-----	-----	-----	-----	-----
172	Roser	1892	Apr. 25	l	r	Sept. 28	f	8	8	3-4
173	Roseville	1892	" 27	l	g	" 4	c	9½	5	5
174	R. S. Stevens	1891	" 25	s	r	Aug. 31	f	3½	9	4
175	Salway	1890	" 27	s	r	Sept. 21	f	4½	6	6
176	Scott	1890	" 27	s	g	" 9	f	3¾	5	7
177	Sener	1888	" 25	s	r	Aug. 31	f	6	5	7-8
178	Shipley	1890	" 27	s	g	Sept. 4	f	5¾	8	4-5
179	Smock (free)	1888	" 28	s	r	" 14	f	5½	4	5-6
180	Smock X	1892	" 28	s	r	" 17	f	5¼	10	5-6
181	Sneed	1896	-----	-----	-----	-----	-----	-----	-----	-----
182	Snow Late	1890	Apr. 27	s	r	Aug. 17	f	4	7	6
183	Southern Early	1890	" 25	s	r	" 17	f	4	4	6
184	Spottswood	1894	" 27	l	r	Sept. 11	f	4½	1	5
185	Stark Heath	1892	" 25	s	r	Oct. 1	c	5¼	6	7
186	Steadly	1888	" 27	s	r	Sept. 21	f	5	7	7-8
187	Stevens Late	1890	" 27	s	r	" 16	f	8	6	4-5
188	Stevens Rareripe	1892	" 27	s	r	" 9	f	5½	7	7
189	St. John	1890	" 27	s	g	Aug. 1	f	6	6	7-8
190	Strong (Mam.)	1892	" 27	s	g	Sept. 11	f	5¾	8	6
191	Stump	1890	" 25	s	g	Aug. 8	f	4½	10	6
192	Summer Snow	1894	" 27	l	g	Sept. 22	c	3¾	2	4-5
193	Surpasse (Mel.)	1890	" 27	s	r	Aug. 17	f	4	4	8
194	Switzerland	1890	" 27	s	g	Sept. 4	f	4¾	5	5-6
195	Tallman 1	1894	-----	-----	-----	-----	-----	-----	-----	-----
196	Tallman 2	1894	-----	-----	g	-----	-----	-----	-----	-----
197	Tallman 3	1894	-----	-----	g	-----	-----	-----	-----	-----
198	Toledo	1894	Apr. 27	l	g	Aug. 6	f	3½	2	6
199	Toquin	1892	" 27	l	r	Sept. 3	f	3½	7	7
200	Townsend	1892	" 27	s	g	" 12	f	6	5	5-6
201	Triumph	1896	-----	-----	-----	-----	-----	-----	-----	-----
202	Troth	1890	Apr. 25	s	g	Aug. 10	f	3¾	10	4-5
203	Tuskena	1892	" 25	s	r	Sept. 22	c	5½	1	8-9
204	Wager ?	1894	" 27	s	r	" 14	f	4½	4	-----
205	Walker	1892	" 27	s	g	" 15	f	7½	6	6-7
206	Walker Var.	1890	" 27	s	g	" 12	f	4½	9	7-8
207	Washington	1890	" 27	s	g	Aug. 31	f	6¼	6	3-4
208	Waterloo	1888	" 28	l	r	July 6	s	3	10	5
209	Willett	1894	" 27	l	r	-----	-----	-----	1	-----
210	Williamson	1892	" 27	s	g	Sept. 12	f	6	9	5-6
211	Wonderful	1890	" 27	s	r	" 21	f	5½	8	5
212	Worthen	1892	" 25	s	r	Aug. 20	f	6	8	8
213	Yellow Rareripe	1888	" 27	s	g	" 18	f	3	7	3-4
214	Yenshi	1896	-----	-----	-----	-----	-----	-----	-----	-----
215	York Pearl	1896	-----	-----	-----	-----	-----	-----	-----	-----
216	Zella	1896	-----	-----	-----	-----	-----	-----	-----	-----

NOTES ON VARIETIES.

Peaches Ripening in July—All Semi-clings.

Waterloo was the earliest to ripen; and, so far, one of the most productive. Champion, a seedling from Allegan, Michigan, is a serrate-leaved variety which, for several years, was considered worthless, on account of the mildewing of the foliage and young wood, usually so injurious to varieties of this type which, however, yields readily to the copper-sulphate treatment, applied to the dormant plant. Under this treatment, the variety proves fairly productive and vigorous, and less clingy than most others ripening at this season.

River Bank, received from Missouri, and Canada, from Ontario, follow the foregoing very closely.

Alexander and Amsden, although of distinct parentage, may, for all practical purposes, be considered identical. Although scarcely equal in quality to Waterloo, they are almost the sole representatives of this type of peaches in western Michigan.

Rivers, an English seedling, easily takes rank as the best, most beautiful and profitable of the early semi-clings.

Hyatt, Hale X (a seedling by C. Engle, of Paw Paw, Michigan), Japanese Dwarf, Haas, Hale and Hynes, have all ripened this year, in the order given, within the month of July.

Varieties Ripening in August.

Of the varieties which fruited at the station this season, sixty-eight ripened during the month of August. Of these the following thirteen ranked from nine to ten in productiveness, viz: Amelia, Bequett free, Early Barnard, Early Crawford 1 and 3 (of C. Engle), Early Michigan (16), June Rose, Kalamazoo, Minnie (of Texas), Mountain Rose, Muir, Mystery and Stump (World); while, of the same, barely four, viz: Champion (of Ohio), Early Michigan, Engle (Mam.), and Morris White, grade as high as nine to ten in quality.

September Varieties.

Of the remaining varieties fruiting this year, ninety-two ripened during September, of which the following twenty-six are graded at nine to ten for productiveness, viz.: Allen, Bonanza, Blood Leaf, Chili, Chili 2 (of Engle), Columbia, Crothers, Geary, Gold Drop, Hance Smock, Kallola, Lovett White, Magdala, Marshall, McCollister, Morris Co., Muir, N. Am. Apt, Nectarine, Oldmixon free, Pearl, Princess (Wales), Smock X, Walker Var., and Williamson, of which only a single variety, the Oldmixon free, ranks as high as nine to ten in quality.

October Varieties.

Iron Mountain, Normand and Stark Heath matured during the early days of October. Brett was assumed to be mature on or about the middle of the month, while the first crop of Ice Mountain was yet immature when the first freezing weather occurred during the latter half of the month.

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GRAPES.—(*Vitis*).

The fact will doubtless be recollected that, during the spring of last year, a severe frost occurred, after the growth of the young canes was well advanced, which nearly or quite ruined the incipient canes. The injured canes were allowed to remain; and many of the buds upon them subsequently developed new canes. These, together with the additional canes subsequently produced from the old wood, soon multiplied the number of young canes beyond the ability of the plants to produce strong fruiting wood for the following year, rendering it highly probable that the better practice would have been to entirely remove the injured growths, and depend wholly upon new growths from dormant buds. Many of the weaker canes were cut away when the error became obvious, although too late to insure the best results.

The crop of this year has apparently been considerably diminished from this cause.

The spray of copper sulphate (one pound in twenty-five gallons of water), with which all dormant plants were treated, was applied to grapes on April 15th.

On June 12th, grapes were sprayed, to prevent anthracnose, with a solution of one pound of copper-sulphate in 200 gallons of water.

On July 11th to 21st, finding indications of mildew, grapes were again treated with a solution of one pound of copper-sulphate in 250 gallons of water.

Mildew proving unusually persistent, the latter solution was again applied on August 4th and 5th, and again on the 13th.

No attacks of either fungi or insects have proved troublesome, beyond those already specified.

In the column headed Parentage, in the following table, the species of the mother or seed parent is first given, and followed by the known or supposed cross. In the determination of such parentage, the writer has been very kindly aided by Prof. T. V. Munson, of Texas, who is generally recognized as the leading expert in this country, so far as the botany of the grape is concerned.

In the great majority of cases, the actual parentage can only be inferred from the characteristics of the resultant plant, or the tendencies manifested in seedlings therefrom; it will therefore be understood that, in many cases, conclusions are drawn from such premises.

GRAPES.

Number.	Name.	Parentage.	Planted.	Bloomed.	Ripened.	Form—c, compact; y, cylindrical; l, long; o, oval; r, round; s, shouldered. Bunch.	Form— Berry.	Color—a, amber; b, black; r, red; w, white.	Weight of bunch in ounces.	Productiveness—scale (1–10).	Quality—scale (1–10).
1	Adirondac	Lab. x Vin.	1890	June 3.	Aug. 2	l c s	-----	b	---	3	5
2	Agawam	Lab. x Vin.	1888	May 27.	m Sept.	l s	r	b	5	7	6–7
3	Aminia	Lab. x Vin.	1888	" 27.	m Sept.	l s	r	b	5	8	7–8
4	Aug. Giant	(Rip. x Lib.) x Vin.	1889	June 1.	b Sept.	l s	r	b	4	1	5
5	Barry	Lab. x Vin.	1888	May 29.	m Sept.	r c s	r	b	4	7	7
6	Beagle		1889	" 25.	Aug. 9	y o	r	b	2	5	8
7	Bell	Elvira x Dela.	1889	" 25.	b Sept.	y o	r	w	3	7	8
8	Belvidere	Lab.	1892	" 25.	Aug. 20.	c s	r	b	4	9	6
9	Berckmans	Clinton x Dela.	1892	" 25.	e Sept.	l o	r	r	2	7	8–9
10	Berlin	Lab.	1893	-----	-----	-----	-----	-----	---	---	-----
11	Black Eagle	Lab. x Vin.	1890	June 1.	m Sept.	l c s	o	b	4	3	6
12	Black Pearl	Rip. x Lab.	1892	May 25.	b Oct.	y o	r	b	---	3	3–4
13	Blanco		1889	" 26.	m Sept.	y s	r	w	4	6	4
14	Brighton	Lab. x Vin.	1888	" 29.	b Sept.	l s	r	r	6	3	10
15	Brilliant	Lab. x Vin.	1889	June 1.	m Sept.	y c s	r	r	4	9	9–10
16	Brunette	Lab. x Vin.	1892	-----	-----	-----	-----	-----	---	---	-----
17	Cambridge	Lab.	1890	May 27.	Sept. 20.	y s	r	b	4	4	7
18	Catawba	Lab. x Vin.	1888	" 29.	m Oct.	l o s	r	r	3	5	8–9
19	Caywood 50	Lab.	1888	" 25.	b Sept.	l	r	b	8	10	6–7
20	Centennial	Lab. x Vin.	1892	June 3.	e Sept.	y s	r	w	8	10	10
21	Challenge	Lab. x Vin.	1892	May 25.	-----	-----	-----	-----	---	---	-----
22	Champion	Lab.	1889	" 25.	Aug. 19.	c s	r	b	3	7	3–4
23	Chidester 3	Lab.	1892	" 30.	Aug. 31.	r s	r	a	2	3	9
24	Chidester 4	Lab.	1892	June 3.	m Sept.	r	r	b	3	3	6–7
25	Clark		1892	-----	-----	-----	-----	-----	---	---	-----
26	Clevener	Rip. x Lab.	1892	May 25.	Aug. 15.	y	r	b	3	5	4
27	Clinton	Rip. x Lab.	1891	" 25.	l Sept.	c y s	r	b	3	3	4
28	Colerain	Lab.	1892	" 29.	m Sept.	c	r	w	---	1	8
29	Columbia	Rip. x Lab.	1891	" 29.	-----	-----	-----	-----	---	---	-----
30	Columbian	Lab.	1895	-----	m Sept.	l	r	r	---	1	4
31	Concord	Lab.	1888	May 29.	e Sept.	y s	r	b	6	8	6–7
32	Cortland	Lab.	1890	" 25.	e Aug.	o s	r	b	4	3	3–4
33	Cottage	Lab.	1890	" 25.	b Sept.	y	r	b	4	7	5
34	Creveling	Lab. x Vin.	1890	" 28.	m Sept.	-----	r	b	---	1	-----
35	Delaware	Bour. x Lab. ?	1888	" 29.	m Sept.	c s y	r	r	5	8	10
36	Diamond	Lab. x Vin.	1889	" 26.	b Sept.	l c s	r	w	5	8	7–8
37	Diana	Lab. x Vin.	1888	" 27.	e Sept.	c y	r	r	4	8	6–7
38	Downing	Æst. x Vin.	1888	June 3.	e Sept.	l c s	o	b	7	10	9–10
39	Dracut	Lab.	1891	May 25.	Aug. 31.	y s	r	a	4	3	2–3
40	Duchess	Lab. x Vin.	1888	June 4.	e Sept.	l s	r	w	7	9	10
41	Early Golden	Lab. x Vin.	1889	May 26.	Aug. 19.	-----	r	w	2	7	5
42	Early Market	Lab. x Rip.	1889	" 26.	Aug. 31.	o s	r	b	3	8	8
43	Early Victor	Lab. x (Bour. x Lab.)	1888	" 26.	Aug. 31.	o c s	r	b	4	7	7–8
44	Eaton	Lab.	1888	" 29.	m Sept.	l s	r	b	8	9	6
45	Elaine	Lab. x Vin.	1889	" 29.	-----	-----	-----	-----	---	---	-----
46	El Dorado	Lab. x Vin.	1889	June 1.	-----	-----	-----	-----	---	---	-----
47	Elvira	Lab. x Rip.	1892	May 25.	m Sept.	y	r	w	4	7	4
48	Empire State	Lab. x Vin.	1888	June 1.	e Sept.	y s	r	w	6	7	8–9
49	Essex	Lab. x Vin.	1889	June 1.	m Sept.	c s	o	a	4	8	3–4
50	Esther	Lab. x Vin.	1892	May 29.	m Sept.	y	r	w	---	7	4
51	Etta	Lab. x Rip.	1892	" 26.	m Oct.	c s	r	w	4	7	4–5
52	Eugenie	Lab.	1891	" 29.	m Sept.	l o	r	r	---	1	-----
53	Eumelan	Lab. x Vin.	1888	June 1.	m Sept.	l s	r	b	5	9	8
54	Eva	Lab.	1889	May 26.	b Sept.	c s	r	w	---	3	3–4
55	Faith	Lab. x Rip.	1891	" 25.	b Sept.	-----	r	w	---	1	5

GRAPES.—CONTINUED.

Number.	Name.	Parentage.	Planted.	Bloomed.	Ripened.	Form—c, compact; y, cylindrical; l, long; o, oval; r, round; s, shouldered. Bunch.	Berry.	Color—a, amber; b, black; r, red; w, white.	Weight of bunch in ounces.	Productiveness—scale (1-10.)	Quality—scale (1-10).
56	Gaertner	Lab. x Vin.	1889	June 1.	m Sept.	------	r	r	----	8	5
57	Geneva	Lab. x Vin.	1892	" 1.	m Sept.	l o	o	w	8	1	5
58	Goethe	Lab. x Vin.	1889	May 30.	e Sept.	l s	r	w	4	7	5-6
59	Golden Drop	(Lab. x Vin.) x (Bour. x Lab)	1889	May 29.	Aug. 27.	y s	r	w	2	8	9-10
60	Golden Gem	(Bour x Lab.) x Vin.	1891	" 25.	----------	------	------	------	----	----	------
61	Guinevra	Lab. x Vin.	1892	" 30.	b Oct.	y o	o	w	6	8	3-4
62	Hall	Lab.	1893	" 29.	m Sept.	c s	r	b	4	4	6-7
63	Hartford	Lab.	1889	" 30	e Aug.	l c s	r	b	4	4	3-4
64	Hayes	Lab.	1888	" 29.	b Sept.	y s	r	w	4	8	6-7
65	Herbert	Lab. x Vin.	1889	" 30.	m Sept.	l s	r	b	----	7	7
66	Honey	Lab. x Vin.	1892	" 26.	m Sept.	y s	r	w	8	2	7-8
67	Hosford	Lab.	1893	June 1.	m Sept.	y s	r	b	6	8	5-6
68	Ionia	Lab. x Vin.	1888	" 2.	m Sept.	l s	o	w	7	9	10
69	Iris	Lab. x Vin.	1892	May 30.	m Sept.	r o s	r	a	----	1	5-6
70	Isabella	Lab. x Vin.?	1888	" 27.	b Oct.	l s	o	b	5	7	8
71	Ives	Lab.	1890	" 25.	e Sept.	y s	r	b	5	9	3-4
72	Janesville	Lab.	1889	" 25.	b Sept.	r y s	r	b	5	7	6
73	Jefferson	Lab. x Vin.	1888	June 4.	e Sept.	r y s	r	r	8	8	8-9
74	Jessica	Bour x Lab.	1888	May 25.	Aug. 22.	y s	r	w	4	8	6
75	Jewell	Bour x Lab.	1890	" 29.	Aug. 26.	s	r	b	3	3	4
76	Josselyn 5	Lab.	1891	" 30.	e Sept.	o y	r	w	----	5	4
77	Josselyn 7	Lab.	1891	June 6	e Sept.	y s	r	w	3	5	10
78	Josselyn 9	Lab.	1891	" 1.	e Sept.	y c	r	b	3	5	4-5
79	Josselyn 10	Lab.	1891	May 30.	----------	------	------	------	----	----	------
80	Lady	Lab.	1888	" 29.	Aug. 27.	y	r	w	4	8	6
81	Leader	Lab.	1892	" 29.	m Sept.	y o	r	w	----	7	5-6
82	Leavenworth	Lab.	1893	" 27.	Sept. 20.	o s	r	b	3	2	6-7
83	Lindley	Lab. x Vin.	1889	" 29.	e Sept.	l s	r	r	4	8	6-7
84	Lutie	Lab.	1892	" 25.	m Sept.	r	r	r	3	1	2-3
85	Mason	Lab. x Vin.?	1892	----------	m Sept.	r	r	r	----	1	9
86	Massasoit	Lab. x Vin.	1888	May 29.	m Sept.	r s	r	r	4	7	6-7
87	Merrimac	Lab. x Vin.	1888	" 29	m Sept.	y	r	b	6	7	7
88	Michigan	Lab. x Vin.	1890	June 3.	b Sept.	r y	r	w	----	3	6
89	Millington	Lab.	1891	May 30.	e Sept.	y o	r	b	6	7	5
90	Mills	Lab. x Vin.	1888	June 3.	e Sept.	l y s	r	b	7	9	10
91	Minnesota	Lab.?	1891	" 6.	----------	------	------	------	----	----	------
92	Monroe	(Bour x Lab.) x Lab.	1889	May 29.	e Sept.	l s	r	b	4	1	6
93	Moore Early	Lab.	1888	" 26.	Aug. 20.	o s	r	b	8	9	5
94	Moyer	Bour x Lab.?	1888	" 26.	Aug. 20.	y s	r	r	3	2	6
95	Naomi	(Lab. x Rip.) x Vin.	1889	----------	----------	------	------	------	----	----	------
96	Nectar	Lab. x (Bour. x Lab.)	1888	May 26.	m Sept.	y s	r	r	----	4	4-6
97	Niagara	Lab.	1888	" 25.	e Sept.	c s	r	w	7	3	5-6
98	Northern Light.	Lab.	1890	June 7.	m Sept.	y o s	r	w	4	10	7-8
99	Olita	Lab. x Vin.	1889	" 1.	m Sept.	y c	r	w	----	7	6
100	Oneida	Lab. x Vin.	1892	May 29.	e Sept.	o o	r	r	3	3	6-7
101	Osage	Lab.	1892	" 29.	Aug. 24	o	r	b	8	3	5
102	Owosso	Lab.	1893	" 30.	e Sept.	r y s	r	a	4	2	4-6
103	Ozark	Est.	1893	----------	m Oct.	y	r	b	2	1	5
104	Peabody	Rip.	1893	May 29.	Aug. 19.	l y	r	b	5	8	6
105	Perkins	Lab.	1890	" 25.	b. Sept.	c y s	r	a	3	8	3
106	Pocklington	Lab.	1888	" 26.	Sept. 15.	y s	r	w	6	9	6
107	Poughkeepsie	Bour x Lab.	1888	June 3.	b Sept.	y c	r	r	3	7	9-10
108	Prentiss	Lab. x Vin.	1890	May 29.	m Sept.	y c	r	w	5	9	8
109	Presley	(Lab. x Rip.) x Lab.	1889	" 25.	e Sept.	y c s	r	r	8	8	4-5
110	Progress	Lab. x Vin.	1892	June 1.	e Sept.	c r	r	b	6	7	10

GRAPES.—CONCLUDED.

Number.	Name.	Parentage.	Planted.	Bloomed.	Ripened.	Form—c, compact; y, cylindrical; l, long; o, oval; r, round; s, shouldered. Bunch.	Form—c, compact; y, cylindrical; l, long; o, oval; r, round; s, shouldered. Berry.	Color—a, amber; b, black; r, red; w, white.	Weight of bunch in ounces.	Productiveness—scale (1-10).	Quality—scale (1-10).
111	Pulpless	Lab. x Vin.	1892	May 29.	----	----	----	----	----	----	----
112	Bentz	Lab.	1889	" 26.	m Sept.	c s	r	b	----	7	3-4
113	Requa	Lab. x Vin.	1892	" 29.	m Sept.	c y s	r	r	4	8	7-8
114	Rochester	Lab. x Vin.	1892	" 29.	m Sept.	y c s	r	r	5	10	7-8
115	Rockwood	Lab.	1892	" 27.	Aug. 31.	l c s	r	b	4	7	7-8
116	Rogers 5	Lab. x Vin.	1889	June 1.	m Sept.	r c	r	r	----	8	8
117	Rogers 8	Lab. x Vin.	1889	May 29.	Sept. 15.	r c	o	b	6	7	7
118	Rogers 24	Lab. x Vin.	1889	" 29.	e Sept.	c s	r	r	6	7	6-7
119	Rogers 30	Lab. x Vin.	1889	" 27.	e Sept.	o s	r	r	3	7	5
120	Rommell	(Lab. x Rip.) x Vin.	1889	" 26.	e Sept.	o s	r	w	4	5	4-5
121	Salem	Lab. x Vin.	1888	" 27.	m Sept.	o s	r	r	----	7	4-5
122	Secretary	(Lab. x Rip.) x Vin.	1892	" 26.	m Sept.	c s	r	b	8	9	8
123	Telegraph	Lab.	1892	" 26.	Aug. 27.	c s	r	b	5	7	5-6
124	Themis	Lab. x Vin.	1892	June 1.	m Sept.	o s	r	b	5	7	5-6
125	Triumph	Lab. x Vin.	1892	" 6.	m Oct.	l c s	r	w	12	6	?
126	Ulster	Lab. x Vin.	1888	May 25.	Sept. 16.	y c	r	a	4	8	9-10
127	Vergennes	Lab.	1889	" 26.	m Sept.	l c s	r	r	5	9	7
128	Vesta	Lab. x Vin.	1891	----	----	----	----	----	----	----	----
129	Victoria (white)	Lab.	1892	May 29	----	----	----	----	----	----	----
130	Victoria (black)	Lab.	1891	" 30.	b Oct.	l y	r	b	6	8	6
131	Warder	Lab.	1892	----	----	----	----	----	----	----	----
132	Washington	Lab. x Vin.	1888	June 3.	Oct. 1.	l c s	r	w	6	7	6-7
133	Wells	Lab.	1892	May 25.	----	----	----	----	----	----	----
134	White Ann Arbor	Lab.	1889	----	b Sept.	c	r	w	3	1	5
135	White Beauty	Lab. x Vin.?	1892	June 4.	e Sept.	y c	r	w	3	1	6
136	White Imperial	Lab. x Vin.?	1892	May 29.	b Sept.	y	r	w	3	7	6-7
137	Wilder	Lab. x Vin.	1888	" 26.	m Sept.	s	r	b	5	6	7-8
138	Willis	Est. x ?	1892	" 29.	b Sept.	c s	r	w	----	7	5-6
139	Winchell	Lab. x Vin.	1889	" 29.	Aug. 15.	l c s	r	w	5	9	9-10
140	Witt	Lab. x Vin.	1889	June 1.	e Sept.	c s	r	w	5	8	7-8
141	Woodruff	Lab. x Vin.	1888	May 25.	m Sept.	r s	r	r	5	5	5-6
142	Worden	Lab.	1888	" 27.	e Aug.	l s	r	b	6	9	7-8
143	Wyoming	Lab.	1858	" 26.	b Sept.	l s	r	r	3	6	4

The Rogers' hybrids, of which no less than sixteen are here tabulated, although the berries are generally of fine size and fair quality, and the plants vigorous, under ordinary treatment, frequently produce so large a percentage of imperfect clusters, and are withal so liable to mildew that they scarcely take rank as commercial varieties, while they hold but a questionable position in the amateur or home list.

Elaine, Guinevra, Honey, Michigan, Olita, Pulpless, Themis and Vesta are seedlings by C. Engle, of Michigan, from one or another of the foregoing, which are in process of being tested here, some of which appear very promising, though requiring farther trial to justify a confident conclusion respecting them.

Beagle, Bell, Blanco, Brilliant, Early Market and Presley are seedlings by T. V. Munson, of Texas, several of which prove successful farther south, but are evidently beyond their lattitude here.

Berckmans, Centennial, Duchess, Golden Drop, Golden Gem, Moyer, Poughkeepsie, Prentiss, and perhaps a few others, though often good and several of them of excellent quality, either from feebleness of plant or

special liability to disease are scarcely desirable, unless, possibly to the curious and painstaking amateur; although the thorough and persistent use of fungicides may be expected, in most cases, to insure satisfactory returns of fruit of superior quality.

Brighton, Delaware, Downing, Empire State, Iona, Jefferson, Mills, Washington (Lady) and Winchell are all of high and several of them are of superior quality, and, although they possess more or less of Vinifera blood, and may therefore be the more liable to mildew, such tendency is comparatively slight and easily controlled; while, generally, they are sufficiently vigorous and abundantly productive under judicious management.

Catawba, Triumph and (in many localities), Isabella, although of fine quality when well ripened, can scarcely be relied on to thoroughly mature in this latitude, except in favorable seasons or in specially favorable locations.

Berlin and Hosford originated at Ionia, Michigan. They are not yet sufficiently tested here.

Chidester 3 and Chidester 4 are promising seedlings originated by a gentleman of that name near Battle Creek, Michigan.

Hall is a recent seedling of southern Michigan, which gives promise of value, as an early market grape.

Mason (the name of the lady originator), is an Ottawa county seedling which fruited here for the first time this season. The fruit is of superior quality.

Owosso originated many years since, in the town of that name. It is a seedling of Catawba, which it resembles, in color and general appearance, though ripening earlier.

White Ann Arbor and Woodruff originated at Ann Arbor, Michigan. They give little promise of value for this locality.

Diamond, Early Victor, Eumelan, Josselyn 7, Lady, Progress (identical with Norfolk), Rockwood, Ulster and Witt are hardy and productive varieties of fair to good quality, suitable for the home plantation.

Vergennes, Worden and Northern Light (the last a recent Ontario seedling), while suitable for home planting are, at the same time, desirable for the market.

Jewell, Leavenworth, Osage, Ozark, White Beauty and White Imperial were received from Dr. Stayman, of Kansas, and have now fruited; some of them, the last especially, give indications of value, though farther trial is needful to properly determine their status.

Plants under the name Victoria have been received from several sources. Among these, one proves to be a black grape and an other white; and since both purport to have originated with the late Mr. Miner, it becomes a question which is entitled to the name.

Among those not mentioned in these notes are many desirable and popular varieties which, if of real value, are generally too well known to require special mention.

PLUMS—(*Prunus*).

Whether caused by the copper sulphate spray applied in April to plums in common with all other fruits, or from other cause, the plum trees have been notably exempt from the attacks of fungus, except that there was a very considerable loss of fruit from rot (*Monilia fructigena*) during the month of September, this being its first appearance upon the plum upon the station grounds, although it had been slightly noticeable, a year earlier, upon some of the earlier peaches.

The crescent of the curculio was observed, and the jarring process commenced as early as May 14, finding a good many insects. The jarring was continued, except during high winds, till June 12, when the insect had disappeared.

The first rose chafer (*Macrodactylus subspinosus*) was discovered on May 27, and a few as late as June 5, after which date no more were seen. A few were caught upon roses, though they have been conspicuous this year by their absence.

This year's crop of plums was comparatively light, due doubtless to the excessive crop of last season.

PLUMS.

Number.	Name.	Species.	Planted.	Bloomed.	Ripened.	Color—b, black; p, purple; r, red; w, white.	Adhesion—c, cling; f, free.	Weight of specimen in ounces.	Productiveness—scale (1-10).	Quality—scale (1-10).
1	Abundance	Hattan	1895	Apr. 27	----	----	----	----	----	----
2	Agen Prune	Domestica	1890	" 25	Aug. 14	p	f	¾	1	----
3	Archduke	Domestica	1892	" 25	" 25	b	f	1⅓	1	3-4
4	Arctic	Domestica	1890	" 27	July 27	b	f	¾	10	5
5	Baker Prune	Domestica	1893	" 27	----	----	----	----	----	----
6	Bavay	Domestica	1890	" 22	m Sept.	w	c	1¼	8	10
7	Black Diamond	Domestica	1892	" 25	Aug. 19	b	f	2	10	5-6
8	Black Prune	Domestica	1888	" 27	" 1	p	c	1⅓	10	4
9	Botan	Hattan	1890	" 21	July 20	r	c	2	4	6
10	Bradshaw	Domestica	1890	" 24	----	----	----	----	10	----
11	Burbank	Hattan	1893	" 24	July 20	r	c	2	8	6
12	Burbank 2	Hattan	1890	" 22	" 25	r	c	2	10	7
13	Burbank 7	Hattan	1890	" 21	Aug. 27	w	f	2	5	7
14	Chabot	Hattan	1890	" 27	" 15	r	c	1⅓	2	5
15	Coe	Domestica	1893	" 27	m Sept.	w	c	2	8	6
16	Cook	Hortulana ?	1890	" 25	July 29	r	c	¾	10	4
17	Czar	Domestica	1890	" 25	----	----	----	----	----	----
18	De Soto	Americana	1888	" 29	Aug. 20	r	c	1	8	----
19	Engle	Domestica	1890	" 25	July 25	w	f	1	5	8-9
20	Englebert	Domestica	1890	" 25	Aug. 18	b	f	¾	8	6-7
21	Field	Domestica	1892	" 27	" 3	b	c	2	1	4
22	Forest Garden	Americana	1889	" 28	" 18	r	c	1	5	5
23	Forest Rose	Hortulana	1890	" 28	" 28	r	c	1	1	5-6
24	French Damson	Domestica	1893	" 29	----	----	----	----	----	----
25	Garfield	Hortulana	1889	May 1	----	----	----	----	----	----
26	Glass	Domestica	1890	Apr. 25	Aug. 8	b	c	1¼	1	6
27	G. No. 4	Domestica	1893	" 27	" 29	p	c	2	1	7-8
28	Grand Duke	Domestica	1890	" 22	Sept. 9	b	c	2¾	10	5-6
29	Gueii	Domestica	1890	" 25	Aug. 3	p	f	1	4	5-6
30	Hungarian	Domestica	1888	" 28	July 31	b	f	1¼	5	5-6

PLUMS.—CONCLUDED.

Number.	Name.	Species.	Planted.	Bloomed.	Ripened.	Color—b, black; p, purple; r, red; w, white.	Adhesion—c, cling; f, free.	Weight of specimen in ounces.	Productiveness—scale (1-10).	Quality—scale (1-10).
31	Jewell	Americana	1890	Apr. 29	July 30	r	c	1	5	3-4
32	Kingston	Domestica	1890	" 24	Aug. 15	b	c	2¾	10	6
33	Lincoln	Domestica	1890	" 27	----	----	----	----	----	----
34	Lombard	Domestica	1890	" 27	Aug. 3	p	c	1	10	5
35	Long Fruited	Hattan	1590	" 24	July 18	r	c	1½	3	4
36	Lyon	Domestica	1890	" 27	" 31	w	f	2	9	7-8
37	Maquoketa	Americana	1888	" 29	Aug. 23	r	c	1	5	9-10
38	Mariana	Cerasifera	1890	" 27	July 27	r	c	1	3	2-3
39	Marunka	Domestica	1888	" 27	" 25	p	f	2	2	7
40	Maru	Hattan	1890	" 24	" 26	r	c	1	4	5
41	Middleburg	Domestica	1890	" 24	Sept. 4	w r	f	1	4	8
42	Miner	Hortulana	1890	" 29	" 1	r	c	1	6	3-4
43	Moldavka	Domestica	1888	" 27	July 30	w	f	2	2	6-7
44	Monarch	Domestica	1893	" 24	Sept. 15	p	c	1¾	2	7
45	Moreman	Hortulana	1890	" 30	July 26	r	c	1	4	6
46	Murdy	Domestica	1892	" 29	----	----	----	----	----	----
47	Naples ?	Domestica	1889	" 27	Aug. 3	p	f	1	5	5-6
48	Newman	Angustifolia	1890	May 4	----	----	----	----	----	----
49	Niagara ?	Domestica	1890	Apr. 27	Aug. 3	p	f	1	1	6
50	Nicholas (White)	Domestica	1890	" 27	" 14	p	c	1¼	1	5
51	Ogon	Hattan	1890	" 25	July 13	w	f	1½	1	3
52	Orel 20	Domestica	1888	" 28	" 30	b	f	⅜	2	2-3
53	Pissard	Myrobalan	1889	" 27	----	----	----	----	----	----
54	Pottawattamie	Hortulana ?	1894	" 29	----	----	----	----	----	----
55	Prairie Flower	Hortulana	1890	" 29	Sept. 1	r	c	¾	1	4-5
56	Red June	Hattan	1894	" 30	----	----	----	----	----	----
57	Red Nagate	Hattan	1890	" 27	July 29	r	c	1¾	9	4-5
58	Robinson	Angustifolia	1890	" 29	Aug. 1	r	c	¾	7	5
59	Saratoga	Domestica	1890	" 27	" 4	r	f	1	10	6
60	Satsuma	Hattan	1590	" 25	" 24	p	c	2¾	10	7-8
61	Sergent (Robe)	Domestica	1893	Apr. 27	----	----	----	----	1	----
62	Shipper (Pride)	Domestica	1890	" 27	Aug. 10	b	c	1¾	1	4-5
63	Shiro Smomo	Hattan	1890	" 23	July 8	p	c	1½	9	5
64	Shropshire	Domestica	1890	" 27	Aug. 25	b	f	1	9	3-4
65	Simon	Simoni	1888	" 21	July 21	r	c	----	----	----
66	Spanish King	Domestica	1890	" 25	Aug. 4	p	f	1½	10	6
67	Spaulding	Domestica	1890	" 27	----	----	----	----	----	----
68	Van Buren	Americana	1890	" 29	----	----	----	----	4	----
69	Victoria	Domestica	1890	" 27	Aug. 6	r	f	2	10	6-7
70	Wales (Prince)	Domestica	1892	" 29	----	----	----	----	----	----
71	Wangenheim	Domestica	1890	" 23	Aug. 4	----	----	----	2	----
72	Weaver	Americana	1890	" 28	" 24	r	f	1	6	2-3
73	Wickson	Hattan	1895	" 27	" 3	r	----	3	3	5-6
74	Wolf	Americana	1888	" 29	" 20	r		⅜	7	3-4
75	Wyant	Americana	1890	" 29	" 24	w r	f	1	10	2-3
76	Yellow Aubert	Domestica	1888	" 27	" 31	w	c	3	9	7
77	Yellow Egg	Domestica	1893	" 27	----	----	----	----	1	----
78	Yosebe	Hattan	1890	" 24	July 1	p	c	¾	5	3
79	Yosemite Yellow	Americana	1892	" 28	----	----	----	----	----	----

NOTES ON VARIETIES.

Domestica Varieties.

Agen Prune, so far, proves to be a slow grower and a tardy bearer. It showed its first fruit here this year.

Archduke also showed its first fruit at the station this year. It is vigorous and promises well as a market variety.

Bavay, commonly, but improperly, catalogued as Reine Claude, is popular as a late amateur as well as market plum. The full original name, Reine Claude de Bavay, is an unfortunate one, not only on account of its length, but also from its liability to become confounded with the old Green Gage or Reine Claude, an even finer fruit, but now little grown on account of the unsatisfactory character of the tree.

Black Diamond, Grand Duke and Kingston are quite late, very large, productive and showy market plums. The last two, especially, promise to take high rank as commercial varieties.

Bradshaw still holds a prominent position as a market variety.

Lombard, so long a leading market variety, although very productive, is apparently giving place to more modern varieties of superior quality.

Engle, although of high quality, is not, on account of its size, considered by the originator to be worthy of dissemination.

Hungarian.—Two varieties of this name are under trial. One, received from Iowa, is understood to be from Prof. Budd's Russian importation. The other was received, without a history, from the Michigan Agricultural College. Which is genuine is yet to be determined.

Lyon.—This is the variety appearing in previous reports as Bailey; received from S. S. Bailey, of Kent county, Michigan. A Japanese variety having been previously thus named, in honor of Prof. L. H. Bailey, of Cornell, the Michigan State Horticultural Society, at its recent annual session, re-named this Lyon. It is likely to take rank as a profitable, light colored market plum, of quality good enough for family use. It ripened this season early in August.

Middleburg showed its first fruit at this station this year; in quality it is very good, but farther trial is needful to properly determine its status.

Marunka and Moldavka, from the European importations of Prof. Budd, have now fruited three successive years. They are of fine size and good quality, but, so far, lack productiveness.

Gueii, Naples and Niagara.—Trees received under these names have now fruited three years. The last two, if not even the first, are apparently identical with Lombard.

Saratoga is a beautiful and productive variety of fine quality. Its color and size render it desirable for the market. A spurious variety was also received under this name.

Victoria also, as far as tested, appears to possess valuable qualities for both home and market purposes.

Yellow Aubert has, so far, proved to be the finest, largest and most productive of the varieties of plums received from the Budd importations.

A very considerable number of varieties of this species, both new and old have, this year, shown fruit at the station for the first time, but notices of these are deferred to await a farther trial.

Native American Varieties.

Many of these are quite popular at the west and northwest, where the *domestica* varieties fail from one cause or another. Few of them are desirable where the latter can be successfully grown. Robinson, De Soto, Moreman and Hawkeye, which are named as nearly as may be, in the order of their apparent desirability here, are among the most promising of these.

Garfield is exceedingly unproductive, and Golden Beauty, on the other hand, is wonderfully prolific. Both are exceedingly vigorous and hardy. but ripen quite too late for this climate.

Hattan or Japanese Varieties.

Many if not most of these varieties, so far as tested here, seem so inclined to overbear as to seriously endanger the health and longevity of the trees, while their tendency to early blooming is quite likely to, in some degree, diminish their value for localities liable to late spring frosts.

In most lake shore localities, where late spring frosts are rare, several of these are likely to prove useful for market purposes, though, of those so far tested here, none will compare, in flavor, with very many of the *domestica* varieties.

They also generally have the peculiar habit of parting from the stem as soon as ripe, so that, since they ripen more or less in succession, it becomes necessary to go over the trees several times before all are gathered.

Abundance, so long popular among market planters, is found to be identical with one of the Botans.

Burbank, which, more recently, has become quite popular, is larger than Abundance and slightly better flavored. The tree is a vigorous, very spreading grower, and abundantly productive.

Chabot is somewhat later than Burbank and by no means its equal in quality.

Long-fruited, as received here, judging by the name, may very probably be spurious. It is apparently identical with Yosebe, which is a small, round plum, of rather poor quality, ripening here, this year, as early as July first.

Ogon, though of fine size, attractive appearance, and very productive, is of quite indifferent flavor.

Red June has not yet shown fruit here. Elsewhere it is commended as valuable.

Red Nagate, as received here from Georgia, is beautiful, productive and excellent, but notices of it from elsewhere indicate that, as fruited here. it may be incorrect.

Maru and Shiro Smomo are much alike in most particulars, only differing slightly in season of ripening. Both are, in many respects, similar to Abundance, though differing in season and in the habits of growth.

Satsuma is a curiosity, with a dark purple skin; the flesh is even darker, with an unusually small pit. The tree is very productive and the fruit large, ripening rather late. It is excellent for culinary purposes.

Wickson fruited heavily here, this season, on cions of but a single season's growth. The foliage is like that of Kelsey, but, unlike that variety, it ripens its wood early, and so far, proves entirely hardy here. Fruit of the form and size of Kelsey. It ripened here, this season, on August third. Weight of an average specimen, above three ounces; quality, medium or above.

PEARS.—*Pyrus communis*.

The spring of 1896, down to nearly or quite the middle of June, proved excessively dry; the showers were few and too slight for any permanent benefit. The remainder of the season has been more favorable, though the rainfall has at no time been excessive.

A considerable number of varieties have fruited here this season, many of them for the first time, though, in most cases, the crop has been light.

The spray, with a strong solution of copper sulphate, applied while growth was yet dormant, has apparently sufficed to prevent the attacks of fungi upon the pear. No treatment, for this purpose, has since been found needful.

PEARS (*Pyrus communis*).

Number.	Names.	Planted.	Bloomed.	Ripened.	Weight of specimen in ounces.	Productiveness—scale (1-10).	Quality—scale (1-10).
1	Alphand	189[illegible]	Apr. 30				
2	Angouleme	1891	" 28	m Sept.	8	1	5
3	Anjou	1888	" 30				
4	Ansault	1889	" 28	b Sept.	6	10	6
5	Barry (P.)	1892	" 29	Nov.-Dec.	5	10	5-6
6	Bartlett	1891	" 29	b m Sept.	8	3	8
7	Bloodgood	1888	" 28	Aug. 3	4	10	5
8	Bosc	1888	" 30	Sept.-Oct.	8	1	10
9	Clairgeau	1891	" 28				
10	Clapp Favorite	1888	" 29	Aug. 8	8	1	6
11	Congress (Souv.)	1890	" 30				
12	Coreless	1891	" 28	e Aug.	8	10	5-6
13	Dana-Hovey	1888	" 28	e Oct.	4	3	10
14	Dearborn	1891	" 29				
15	Duhamel	1891	" 28	Sept. 26	5	8	2-3
16	Early Duchess	1892	" 30	m Sept.	6	2	6-7
17	Elizabeth (Manning)	1891	" 29	Aug. 13	3	1	9-10
18	Fitzwater	1891	" 29	e Sept.	3	4	8
19	Gakovsk	1888	" 29				
20	Giffard	1888	" 28	July 27	4	10	5
21	Gray Doyenne	1888	" 29	Oct.	4	1	9
22	Hardy	1888	" 29				
23	Hoosic	1888	May 2				
24	Howell	1888	Apr. 28	Aug. 17	7	5	5-6
25	Jones	1889	May 1			1	3-4
26	Josephine	189[illegible]	Apr. 28		3	1	5
27	Kurskaya	1888	" 28	Sept.	4	6	2-5
28	Lawrence	1888	" 28	Oct. 23	5	1	8-9
29	Lawson	1889	" 30				
30	Lucrative	1888	" 29	b m Sept.	6	2	8-9
31	Margaret	1889	" 29	July 16	5	2	4
32	Millett	1891	" 30	Dec. 7	1	5?	
33	Mount Vernon	1888	" 28	b Oct.	5	2	7-8
34	Ogereau	1891	" 28	Oct.-Dec.	12	10	4-8
35	Onondaga	1891	" 29	b Oct.	7	1	7
36	Pitmaston	1891	" 29				
37	Reeder	1890	" 28	m Oct.	8	10	7-8
38	Rostiezer	1888	" 28	Aug. 4	4	2	10
39	Rutter	1892	" 28	m Oct.	10	5	7
40	Seckel	1888	" 28	b m Oct.	8	3	10
41	Sterling	1888	" 29	Aug. 15	4	1	5-6
42	Summer Doyenne	1888	" 29	July 30	2	2	5
43	Victorina	1888	" 28	b Aug.	4	4	4-5
44	Winter Nelis	1888	" 30	Oct. 23	8	1	10

To prevent the depredations of the codling moth (*Carpocapsa pomonella*), a spray of Bordeaux and Paris green was applied on May 11, using three ounces of Paris green in fifty gallons of Bordeaux.

On May 23 pears were again sprayed for codling moth, using one pound of copper sulphate and three ounces of Paris green in 250 gallons of water.

Trees were sprayed the third time for codling moth on July 3 to 7.

Strong tobacco decoction was applied to destroy slugs (*Eriocampa cerasi*) on June 9, again on June 15 to 20, on August 12, and finally on August 21.

Only such varieties are included in the previous table, as have bloomed or fruited during the past season.

NOTES ON VARIETIES.

Angouleme, on free stocks, planted in 1891, has now borne its second crop of well-developed fruit. This may be considered singular, since the variety is reputed to be a tardy bearer on free stocks.

Ansault (Bonne du Puits Ansault), planted in 1889, has borne its third crop of full medium-sized fruit, above medium in quality. It bears young and profusely, requiring severe thinning.

Barry (Patrick), a California seedling and a long keeper, is an early bearer here. The tree is a slow straggling grower. Specimens weigh from four to five ounces. Flesh fine grained, juicy, highly vinous in flavor. It requires special care in keeping to prevent shriveling.

Bartlett, Clapp (Fav.) and Howell are market varieties, too well known to require characterization here.

Bloodgood, Giffard, Rostiezer and Summer Doyenne are early varieties of superior quality, specially desirable for home use.

Bosc is large and excellent for both home use and market.

Coreless, received from Missouri, proves identical with Flemish.

Dana-Hovey, though small, is one of the finest of winter pears. The tree also is vigorous and beautiful.

Duhamel (du Monceau) and Early Duchess (Duchesse Precoce), are recently introduced varieties, showing their first fruits here this year.

Elizabeth (Manning), and Fitzwater also fruit here this year for the first time. So far, the latter lacks vigor. Both are of high quality.

Gakovsk, Kurskaya and Victorina are from Prof. Budd's Russian importations. Though vigorous and productive, they promise little value in comparison with many other well known varieties.

Gray Doyenne is one of the oldest European varieties. Though excellent, it is now rarely planted except by curious amateurs.

Jones, Josephine, Lawson and Millett (this last a comparatively recent importation) have each shown their first fruits here this season, though too few to warrant conclusions respecting them.

Lawrence, winter; Lucrative, autumn; Margaret, summer; and Mount Vernon, Onondaga, Reeder, Rutter, Seckel and Winter Nelis, all ripening this year, in October, are valuable, but too well known to require special characterization.

Ogereau, a comparatively recent European variety, is a showy late autumn and early winter pear, weighing twelve ounces. Planted in 1891, it has now produced its second full crop of fruit.

Sterling is a comparatively old variety of American origin; a very beautiful fruit, well adapted to early marketing, and specially exempt from blight.

APPLES.—(*Pyrus malus*).

Apples, while yet dormant, were on April 13th to 17th treated with the strong solution of copper sulphate, in common with other fruit trees.

Bordeaux mixture with Paris green was applied for codling moth on May 11th to 19th, the treatment having been delayed by high winds.

On May 23d to 27th the treatment was repeated, using one pound of copper sulphate and three ounces of Paris green in 250 gallons of water. This treatment was again applied on June 11th, and a final spray of the same was given on July 3d.

These several treatments appear to have been thoroughly effective against the attacks of fungi, though, possibly consequent upon delayed treatment during windy weather, they were but partially effective against the codling moth.

Tobacco decoction, made by digesting tobacco stems for several hours in cold water sufficient to cover them when slightly weighted, proves to be a specific against aphides. These have been rather persistent this season. In subduing them, this spray was first applied on July 8th to 10th, and again on the 25th.

Only such varieties as have bloomed or fruited this season are included in the following table.

Crabs are compared with crabs only, so far as quality is concerned. The word crab, where it appears, is not to be understood as part of the name.

APPLES (*Pyrus malus*).

Number.	Name.	Planted.	Bloomed.	Ripened.	Color—g, green; r, red; s, russet; y, yellow.	Flavor—a, acid; b, sub-acid; s, sweet.	Weight of specimen in ounces.	Productiveness—scale (1-10).	Quality—scale (1-10).
1	August (crab)	1890	Apr. 29	Aug. 10	y r	a	6	1	3-4
2	Babbitt	1890	" 28		y r	b	10	10	5-6
3	Bailey	1888	May 2	Oct.	r	s	10	3	7-8
4	Borovinka	1888	Apr. 29	July 30	y r	b	8	10	5
5	Bough	1888	May 1	" 22	y r	s	10	5	7
6	Bradford	1890	Apr. 30	Nov.	g r	b	5	1	4
7	Buckingham	1892	May 6						
8	Chenango	1888	" 2	July 31	y r	b	8	1	7
9	Clark Orange	1892	" 1						
10	Cogswell	1888		Nov.-Mar.	y r	b	7	1	7-8
11	Colton	1888	Apr. 29	July 11	y r	b	6	10	6
12	Colvert	1892	May 2						
13	Cornell	1890	" 2	Aug. 25	r	b	7	9	5-7
14	Craine	1888	" 2	Dec.	y r	b	4	1	7
15	Cullin	1890	" 1					3	
16	Dartmouth (crab)	1890	Apr. 30	Aug. 8	r	b	3	10	10
17	Dickinson	1889	May 2						
18	Dyer	1888	" 1	Aug. 13	g y	b	6	10	9-10
19	Early Ripe	1891	" 1						
20	Early Strawberry	1888	" 2	Aug. 4			3	2	7
21	Excelsior	1890	Apr. 30	e Aug.	y r	b	6	10	6
22	Fall Pippin	1890	May 4	b Nov.	y r	b	9	1	10
23	Fink	1892	" 2						
24	Flushing	1888	" 2						
25	Gideon Sweet	1896							
26	Gloege	1888	Apr. 30	Nov.-Mar.	y r	b	7	5	4
27	Golden Reinette	1888	May 2	Oct.	r y	b	5	1	4-6
28	Golden Russet (N. Y.)	1883	Apr. 30	Dec.-Mar.	y s	b	6	10	10
29	Greenville	1895							
30	Grindstone	1888	May 1	Dec.-May	g y	b	6	1	3
31	Grosh	1890	Apr. 30	b Sept.	y r	b	6	6	7-8
32	Hargrove	1892	" 30						
33	Hawley	1888	May 2	m Sept.	y	b	11	1	8-9
34	Hubbardston	1888	" 2	Nov.-Feb.	y r	b	9	4	8-9
35	Indian	1892	" 2	b m Sept.	y r	b	9	10	4-5
36	Iowa Keeper	1891	" 2	Dec.	g r	b	6	3	4-6
37	Jefferis	1883	Apr. 30	Aug. 12	y r	b	6	5	9
38	Jelly	1890	" 29	Sept. 16	y r	a	2	8	4
39	Jersey Sweet	1888	May 2	e Aug.	y r	s	6	5	3
40	Jonathan	1885	" 4	Nov.-Mar.	y r	b	7	10	9-10
41	Keswick	1888	Apr. 30	Aug.	y	a	6	10	10
42	Kirkland	1890	May 1					2	
43	Longfield	1892	Apr. 29	Sept. 11	y r	b	7	10	5
44	Lou	1890	" 30	m July	y r	b	5	10	5
45	Louise	1890	May 4					4	
46	Lowell	1890	" 1	Aug. 15	y	b	10	10	6-7
47	Magog	1890	" 1					5	
48	Maiden Blush	1885	" 2						
49	Martha	1890	" 1					1	
50	Mason Orange	1890		Nov.	y	b	8	1	5-6
51	McLellan	1888	May 7						
52	Minkler	1892	Apr. 29	Jan.-Mar.	g y r	b	9	5	6-8
53	Morris (Red)	1890	" 6						
54	Northfield	1890	May 2	Nov.-Dec.	y r	b	7	1	5
55	North Star (crab)	1891	Apr. 29	July 22	r y	a	2	1	6
56	No. 3 New	1890	" 29	m Aug.	g y r	b	5	10	6
57	Oakland	1888	" 30	Oct. 23	y r	b	6	10	7-8
58	October	1890	" 29	Aug. 15	r	b	6	9	5
59	Oldenburg	1892	" 29	" 15	y r	a	8	10	4-6
60	Ontario	1890	May 2	Jan.	y r	b	9	3	6

APPLES (*Pyrus malus.*)—CONCLUDED.

Number.	Name.	Planted.	Bloomed.	Ripened.	Color—g, green; r, red; s, russet; y, yellow.	Flavor—a, acid; b, sub-acid; s, sweet.	Weight of specimen in ounces.	Productiveness—scale (1 to 10).	Quality—scale (1 to 10).
61	Pawpaw	1888	May 4						
62	Peter	1890	" 1	Aug. 6	y r	b	5	6	3-4
63	Pewaukee	1892	" 2						
64	Pickett	1888	" 4	Dec.	y r	b	6	1	4-5
65	Pine Stump	1892	Apr. 29						
66	Primate	1888	" 29	July 13	y r	b	8	10	8
67	Pryor Red Seedling	1888	May 2						
68	Quaker (crab)	1891	Apr. 29	Oct.	y r	b	3	1	6-7
69	Quince (Cole)	1893	May 1	Aug. 8	y	b	7	1	
70	Ramsdell Sweet	1890	" 1					2	
71	Red Aport	1888	" 2					2	
72	Red Astrachan	1888	Apr. 30	July 18	r y	b	6	10	8-9
73	Red Canada	1888	May 4	Jan.-May	r y	b	6	1	9-9
74	Red Dettmer	1888	Apr 29	b Sept.	y r	b	8	1	3-4
75	Red Russet	1890	May 1					1	
76	Rhode Island	1888	" 2	Nov.-Mar.	g y	b	11	1	8-9
77	Ronk	1888	Apr. 30	Nov.-Dec.	g y r	b	8	1	7
78	Rosenhager	1888	" 29	Sept.-Oct.	g r	a	11	10	5-6
79	Roxbury	1888	" 30	Jan.-June	g s	b	6	10	4-5
80	Salome	1888	May 5						
81	Scarlet Cranberry	1891	Apr. 30	Dec.	g r	b	8	1	4
82	Scott Winter	1892	May 1						
83	Sheriff	1891	" 2	Dec.	g r	b	6	1	7
84	Smokehouse	1893	" 2						
85	Stark	1888	Apr. 29	Jan.-May	g y r	b	8	4	4-5
86	Stuart	1890	May 1					3	
87	Summer Pearmain	1888	Apr. 29	Aug. 17	y r	b	5	10	10
88	Summer Rose	1892	" 29	July 30	y r	b	4	1	9-10
89	Thaler ?	1888	" 30	" 10	y r	b	5	1	5
90	Thornton	1892	May 1	Oct.-Nov.	g y r	b	7	9	5
91	Titovka	1888	Apr. 29	July 29	g y r	b	8	9	4-5
92	Tolman	1888	May 4	Nov.-Apr.	y	s	6	1	10
93	Transcendent	1893	Apr. 29	Aug. 16	y r	a	2	10	5-6
94	Wagener	1893	" 20	Nov.-Mar.	r y	b	6	10	8-9
95	Washington (Stry.)	1890	" 30	Aug. 17	y r	b	11	3	7
96	Water	1890	May 1	Oct. 23	y r	b	5	10	5
97	Wealthy	1890	" 1	e Aug.	y r	b	6	10	6
98	Whinery	1890	" 1						
99	Whitney	1890	" 1	e Aug.	r y	b	4	1	6
100	Winter Streifling	1888	Apr. 29	Aug. 26	y r	a	6	10	4-5
101	Yellow Transparent	1888	May 1	July 13	y	a	5	10	3-4
102	Zolotoreff	1890	Apr. 30	July 30	y r	b	9	1	3-4

NOTES ON VARIETIES.

August, Excelsior, Gideon Sweet, Jelly, Lou, Martha, No. 2 New, October, Peter and Wealthy are seedlings originated by Peter M. Gideon, of Minnesota. All are alleged to have sprung, either directly or indirectly, from the crab (Pyrus baccata), and afford, in tree or fruit (one or both), more or less indication of such parentage, excepting only the Wealthy, which affords no evidence of crab parentage, beyond the fact that it appears to be fairly hardy, in many portions of the Northwest. It is a fairly good dessert fruit, while the others are mainly culinary varieties.

Borovinka is very much like Oldenburg, and, for all practical purposes, may be considered identical with it. This, with Golden Reinette, Longfield, Red Aport (much like Alexander), Red Dettmer, Rosenhager, Thaler

(identity doubtful), Titovka, Winter Streifling, Yellow Transparent and Zolotoreff, are all importations from northeastern Europe for trial in the "cold north." Few if any of them seem likely to prove valuable in lower Michigan. Red Astrachan, Oldenburg and Alexander, although long and favorably known in this country, came originally from the same region.

Bough (Sweet Bough or Large Yellow Bough, of the books), has but the one serious fault, that it lacks productiveness.

Chenango (long known about Grand Rapids as Jackson), though easily bruised on account of its delicate texture, is an admirable variety, at least for home use.

Cogswell (an old Connecticut variety), is an excellent longkeeper, though, unfortunately, a rather tardy bearer.

Colton has now borne two heavy successive crops, of fine size and fair quality. It promises well as a very early market variety.

Cornell (Fancy) is an old Pennsylvania variety, adapted to home use rather than the market.

Dartmouth is a large and exceedingly beautiful crab, of fine quality and the tree a good grower and bearer.

Dyer, though only a moderate grower, is a heavy bearer and the fruit, though not very attractive in appearance, is of high quality.

Early Strawberry, though not large, is very beautiful, of excellent quality, and the tree of fine habit.

Fall Pippin, though large, and of superior quality, is true to its reputation as a tardy and thin bearer. The fruit also is much inclined to scab; which however may be mainly prevented by the use of fungicides.

Flushing (Spitzenburg) is prized, in some localities, as a market apple. Some years since, it was widely distributed from a Wayne county nursery, as Red Canada or Steele's Red Winter.

Golden Russet (N. Y.) is commonly known as simply Golden Russet. When well grown and not allowed to shrivel from too free exposure, it has few superiors as a profitable market fruit.

Greenville was originally named *Downing's Winter Maiden's Blush*. This very long and otherwise objectionable name is now changed as above. It has not yet fruited here.

Hawley is very large, beautiful and excellent, but the fruit deteriorates quickly after ripening.

Jefferis is beautiful and excellent. No family orchard or village or city fruit garden should be without it.

Jersey Sweet is the prince among baking sweet apples, for early September.

Jonathan deserves far more attention than it has received thus far, in Michigan, as an excellent winter apple, for both the home plantation and the market. It is popular throughout the west.

Louise, a Canadian seedling, named for Princess Louise, of England. In Yankee land it loses its aristocratic prefix. It is a beautiful and promising fruit.

Lowell is large, productive and profitable.

McLellan is an excellent and very beautiful fruit, and the tree vigorous and productive.

Minkler is old, an early bearer and productive. It is a western variety.

North Star and Quaker are crabs, originating at the Northwest and claimed to be hardy enough for the extreme north. Both are culinary varieties.

Ontario is a seedling by the late Charles Arnold, of Ontario, and is already quite popular in that province.

Ramsdell Sweet (English Sweet) is among the very best dessert and culinary sweet apples for late autumn and early winter.

Red Canada, so long erroneously known throughout Michigan as Steele's Red Winter, is, more recently, losing its former popularity, on account of its feeble habit of growth, as well as increased liability to the attacks of fungi.

Red Russet, though usually more or less russeted, is much like Baldwin in both tree and fruit, though of superior flavor, and perhaps less productive.

Rhode Island is the old well known Greening. There are now so many *Greenings* that the word is no longer distinctive, and is omitted from this in the interest of brevity.

Roxbury, though an excellent longkeeper, is now rarely planted, doubtless largely on account of its tendency to shrivel, when kept in a free exposure, as well as on account of the very spreading habit and deficient hardiness of the tree.

Sheriff comes to us from Nebraska, where it seems to be valued as a hardy longkeeper. It is but partially tested here.

Stark has more or less reputation in Michigan, as a vigorous, hardy and productive longkeeper of only moderate quality.

Summer Pearmain and Summer Rose are early autumn and late summer varieties respectively. Each stands unrivaled in its season for great beauty and superior flavor.

Tolman is one of our most popular baking sweet apples. Recent investigation determines that the correct spelling of the name is as here given.

Transcendent (a quite too sensational name), is probably the most popular of the crabs among Michigan planters.

Wagener is valued for early bearing, great productiveness, and high quality. The tree is usually short lived for such reason.

Washington (Strawberry), though large and beautiful, it is not of high quality. The tree is vigorous and an early bearer.

Whitney (20) has the small size and the long slender stem of the crab, though it differs radically from them in texture and flavor. The tree shows few, if any, of the crab peculiarities, though possessing much of their hardiness.

QUINCES.—(*Cydonia.*)

Prior to the use of Bordeaux mixture at this substation, as a fungicide, the fruit, and occasionally the young growths of the quince, were occasionally attacked by what is usually designated as "Red rust" (perhaps the Gymnosporangium of the Mycologists), which was treated by cutting away and burning.

The foliage, also, was frequently attacked by leaf blight (*Entomosporium maculatum*), a disease common to both this and the pear.

With the free use of Bordeaux, and more recently of a simple solution of copper sulphate, both have disappeared, and the quince has been wholly free from the attacks of fungi, with the exception of an occasional slight visitation of twig blight, akin to that of the apple and pear, which has only proved serious in the case of a single plant of Champion.

No visitations have been discovered of the borers so frequently troublesome with the quince and the apple, which exemption may perhaps be attributable to low branching and the consequent shading of the collars of the trees, at which points such attacks are usually made, and probably in part, to maintaining them in vigorous condition.

The only troublesome insect has been the slug (*Eriocampa cerasi*) which has been unusually persistent this season. Against this insect the decoction of tobacco stems has proved thoroughly effective. It has been applied from time to time as fresh colonies appeared. The first application was made June 9, and the final one August 21.

The crop of this fruit, this season, has been a comparatively light one

QUINCES.—(*Cydonia.*)

No.	Name.	Planted.	Bloomed.	Ripened.
1	Alaska	1891	May 7	m Oct.
2	Angers	1890		
3	Bourgeat	1895	May 7	
4	Champion	1888	May 6	m Oct.
5	Fuller	1891	May 7	
6	Hong Kong	1888		
7	Meech	1888	May 7	e Sept.
8	Missouri	1890	May 7	e Sept.
9	Orange	1888	May 6	m e Sept.
10	Rea	1888	May 6	m e Sept.
11	Van Deman	1895		

NOTES ON VARIETIES.

For the reason that the partially tested varieties may be supposed not to have fully manifested their peculiarities, the tabulation of these particulars is deferred to await more perfect development.

Alaska and Fuller have not yet received a sufficient trial here, but so far they can scarcely be said to be promising.

Angers and Bourgeat are vigorous, upright growers, but neither has yet fruited here.

Champion is vigorous, prolific and an early bearer, but does not always fully mature within our seasons.

Hong Kong, though planted here in 1888, has not yet even bloomed, though it is apparently hardy here.

Meech is a good grower, ripening rather late. Its value, compared with several others may be regarded as doubtful.

Missouri, Orange and Rea are practically very nearly identical.

Van Deman is a quite recent variety, not yet fruited here.

Varieties, so far as fruited, vary somewhat in size, and perhaps slightly in quality, as well as in season; but the old Orange or Apple quince can scarcely yet be said to be even equaled in value for any purpose, unless, possibly, by some of those not yet fully tested.

NUTS.

ALMONDS.—(*Amygdulus communis.*)

Of these, Hard Shell (Luelling), and Soft Shell (unnamed), are on trial, but have, so far, failed to fruit, and have not even bloomed this season.

CHESTNUTS.—(*Castanea.*)

Comfort, planted only last year, has, this season, made a very vigorous growth, but has not yet bloomed.

Hathaway (a seedling from the large native variety originated by the late B. Hathaway), has again shown catkins, but no fruit.

Japan Giant, planted in 1895, has, this season, produced burs, but the nuts proved abortive.

Numbo, planted in 1892, has, this season, produced several abortive burs. The catkins and germs for next season's fruit developed in August and September, quite too late to mature, doubtless at the expense of the next year's crop, and quite probably with increased danger of injury during the coming winter.

Paragon, although severely thinned, still fruited heavily last year. This year's crop is consequently a light one.

Spanish (seedling), produced a large crop of burs, but the nuts were small, and nearly all were abortive.

FILBERTS AND HAZELNUTS.—(*Corylus.*)

Cosford Thin Shell Filbert, planted in 1895, is scarcely yet well established, and, of course, has not yet fruited.

Hazelnut plants (unnamed), were received from the Division of Pomology, at Washington, D. C., in 1892. They have grown vigorously and continue healthy, but have not yet fruited.

Tree Hazelnuts were recently discovered in the state of Washington, of (if recollection is correct) seven or eight inches diameter. Plants were received here for trial in 1893, but failed to make satisfactory growth, and are now dead.

Kentish Cob Filbert, planted here in 1892, has, for several years, produced catkins, but has not, so far, shown fruit. It has withstood our winters, so far, with little if any injury.

PECANS.—(*Carya olivæformis.*)

Seedling (from Iowa seed), planted in 1890, has stood uninjured, without shelter or protection of any kind. It has not yet shown fruit.

Stuart Pecan, grown from Texas seed, planted here in 1894. The plants have been earthed up during the past winters, and yet have killed to the surface in winter, starting from below each spring. This year they have been sheathed with straw, and earthed up still more heavily, with the faint hope that age may increase their hardiness.

WALNUTS.—(*Juglans.*)

Japan Walnut (*Juglans Seiboldii*). This bloomed about the beginning of July, and produced a large crop of nuts, which matured slightly in advance of the first hard frost. The nuts are, in flavor and general appearance, much like our native butternut, though smaller and less roughened, and usually in clusters of nearly or quite a dozen each.

Persian (*Juglans regia*), is hardy here, having been planted in 1890, and stood thus far uninjured, though unprotected. It has made only moderate growths, and has not yet fruited.

Præparturiens (*J. regia*), is a dwarf variety of the Persian, planted in 1890. It has not yet fruited.

Thin Shell (*J. regia?*), was planted in 1894. It appears to be hardy, but has not shown fruit.

APRICOTS.—(*Armeniaca vulgaris*).

The Russian apricots, so called, which had been on trial here since 1888, have been, so far, entirely unproductive and obviously unadapted to this climate and several having died, apparently from lack of hardiness, have now been rooted out.

Harris, a recent variety, originated in central New York and commended by prominent growers there, is the only variety of this fruit retained here This may be expected to fruit during the coming year.

MULBERRIES.—(*Morus*).

Downing is a very vigorous variety, and the fruit of good size and quality, but the tree lacks hardiness for this climate.

Hicks is a southern variety, of fair quality, but of small size as grown here. Though hardy here, it is apparently more successful farther south.

New American is vigorous, hardy and very productive. It is by far the most desirable variety for this climate yet tested here.

Russian is hardy, vigorous and productive; the tree is very spreading, even drooping. The fruit, though very abundant, is small and worthless.
Teas' Weeping is one of the very finest trees of its class when grafted upon an upright stock.

NECTARINES.—(*Persica vulgaris*).

Of this class of fruits there are but two varieties upon the premises, neither of which has shown fruit this season.

ASPARAGUS.—(*Asparagus officinalis*).

Palmetto, which, in previous years, proved superior to either Barr or Conover has, this season, shown little superiority over either.
Columbian (Mammoth White), is as indicated by its name, a peculiar light-greenish white variety, very much like Palmetto, when at its best; perchance a slight improvement. This, however, may be due to the greater vigor of young plants.

RHUBARB.—(*Rheum rhaponticum*).

Of the half-dozen varieties of rhubarb thus far tested, none of the older varieties have proved superior, in either earliness, productiveness or quality to the Linnæus.
Bailey, a more recent seedling, received from S. S. Bailey, of Kent county, Michigan, has unusually dark green foliage, of large size, productive and of excellent flavor. It is eminently worthy of trial.

SOUTH HAVEN, MICH., *January 5, 1897.* T. T. LYON.

VEGETABLES, OLD AND NEW.

BY L. R. TAFT. H. P. GLADDEN AND M. L. DEAN.

CONTENTS.

The following notes give the results of our trials of several hundred varieties of vegetables grown in 1896. The list includes nearly all of the novelties advertised by the various seedsmen, and many of the older sorts for comparison:

The seeds used in our tests were obtained from the following seedsmen.

Francis Brill, Hempsted, L. I.; H. W. Buckbee & Co., Rockford, Ill.; Robert Buist & Co., Philadelphia, Pa.; W. Atlee Burpee & Co., Philadelphia, Pa.; John Lewis Childs, Floral Park, N. Y.; Department of Agriculture, Washington, D. C.; Henry A. Dreer, Philadelphia, Pa.; L. J. Farmer, Pulaski, N. Y.; D. M. Ferry & Co., Detroit, Mich.; James J. H. Gregory & Son, Marblehead, Mass.; Peter Henderson & Co., New York; H. D Hobbs, Williamston, Mich.; Johnson & Stokes, Philadelphia, Pa.; John W. King, Coggeshall, Eng.; D. Landreth & Sons, Philadelphia, Pa.; Wm Henry Maule, Philadelphia, Pa.; W. A. Manda, South Orange, N. J.; Delano Moore, Presque Isle, Me.; Northrup, Braslan, Goodwin Co., Minneapolis, Minn.; Richard Nott, Burlington, Vt.; Oregon Experiment Station, Corvallis, Oregon; John A. Salzer Seed Co., La Crosse, Wis.; J. M. Thorburn & Co., New York; J. C. Vaughan & Co., Chicago, Ill.

BUSH BEANS.

Thirty-five varieties of bush beans were planted May 25 and 26. Most of the varieties made a good stand of plants, and bore a large crop of pods. The wet season made the plants and pods rust badly. Little, if any, difference was noticeable as to amount of rust on one variety as compared with another. The rust attacked the pods after the time they would be gathered for string beans, so little injury was done. In the plat of varieties each sort was thinned to thirty stalks, four inches apart. The last column in the table below gives the average weight of pods, computed from the thirty plants, for each sort grown. The pods were gathered when at the fullest development for string beans.

Variety.	Seedsmen.	Date bloom.	Date edible.	Weight of green pods in ounces for one plant.
Blue Podded Butter	Vaughan	July 10	July 21	3.083
Cylinder Black Wax	Henderson	" 8	" 19	4.083
Davis Wax	Ferry	" 8	" 18	3.333
Detroit Wax	Ferry	" 10	" 21	3.666
Dwarf Horticultural	Ferry	" 7	" 24	3.833
Dwarf Wax No 40	Burpee	" 13	" 27	4.833
Flageolet Victoria	Henderson	" 18	" 21	9.166
Flageolet Violet Wax	Henderson	" 7	" 21	6.666
Flageolet Violet Wax	U. S. Dept. Ag.	" 10	" 21	6.333
Fuller Black Wax	Gregory	" 10	" 23	2.333
Grennell	Gregory	" 10	" 21	5.833
Improved Tree	U. S. Dept. Ag.	" 21	Aug. 4	4.583
Imperial Wax	Vaughan	" 10	July 21	5.166
Keeney's Golden Wax	Burpee	" 10	" 21	6.666
King of the Wax	Dreer	" 10	" 24	5.156
Prolific German Wax	M. A. C.	" 10	" 19	3.75
Red Valentine—Earliest	Henderson	" 10	" 14	5.833
Red Valentine—Extra Early	Landreth	" 10	" 14	6.266
Refugee Wax	Henderson	" 10	" 21	5.333
Roger's Lima Wax	Johnson & Stokes	" 10	" 27	4.000
Saddle Back Wax	Burpee	" 13	" 21	4.500
Stringless Green Pod	Burpee	" 10	" 24	6.666
Thorburn Prolific Market	Thorburn	" 10	" 24	3.416
Valentine Wax	Henderson	" 10	" 14	5.166
Wardwell's Kidney Wax	Ferry	" 10	" 21	6.166
Warren	Vaughan	" 10	" 21	7.416
Yosemite Wax	Vaughan	" 10	" 24	2.666
Japan No. 1	Oregon Ag. Col.	" 10	" 24	3.416
Japan No. 3	Oregon Ag. Col.	" 21	Aug. 13	6.750
California Pea	Hobbs	" 23	" 13	----------
California Pea Lady Washington	Hobbs	" 23	" 15	----------

NOTES ON VARIETIES.

The following are sorts of recent introduction:

Dwarf Wax No. 40, W. Atlee Burpee & Co., Philadelphia. Plants very vigorous and branching; foliage large, light green, with yellowish tinge. Pods form in clusters, well covered with leaves; they are broad and flat, four to five inches long, curved; color, light waxy yellow, tinged with green, quality of the best and stringless. It is somewhat late in

maturing, but the good quality of the pods, length of season, with the large crop borne, make this a very desirable sort for the garden.

Roger's Lima Wax, Johnson & Stokes, appears identical with above.

Fuller Black Wax, James J. H. Gregory & Son, Marblehead, Mass. Differs from Black Wax in having pods that are a little longer, a darker yellow and perhaps less stringy. The plants were less productive than German Wax and the variety as grown here has little to recommend it over that well known sort.

Keeney's Golden Wax, Burpee. A very strong grower, inclining to climb. Foliage large, wrinkled and light green in color. Pods four to six inches long, broad, becoming nearly round as they mature and of a rich yellow color; the quality is of the best and they are stringless for a long time. The plants are very productive, bearing the crop all along the stem, thus also extending the season. For productiveness, length of season and good quality of the pods, this variety has few superiors.

King of the Wax, Henry A. Dreer, Phila. Plant growth strong and compact. The pods are four to five inches long, thick and of a rich yellow color. Valuable for thick tender flesh of good quality and length of season. Productive.

Imperial Wax, J. C. Vaughan & Co., Chicago. Plants of vigorous, rather upright growth, branching very little. Pods five to six inches long, broad and of fine quality; color, a bright waxy yellow; remain in edible condition but a short time. Plants are very productive. Season, medium early. An excellent sort.

Valentine Wax, Peter Henderson & Co., New York. This variety, in plant growth, shape of pod and in appearance of bean is similar to the common Red Valentine. The pods, however, are golden yellow in color, of best quality and free from stringiness. The plants are very productive and the season is early, a valuable acquisition to the wax sorts.

Japan No. 1 and No. 3, Oregon Agricultural College. The seed of these varieties was sent from Japan. The varieties are late in maturing. The plants are productive but the quality of the pods is not good.

California Pea, H. D. Hobbs, Williamston, Mich. Plants very productive and the beans are of the best quality. Excellent sorts of the small pea bean class.

Of the older and better known varieties, *Cylinder Black Wax*, *Flageolet Victoria* and *Saddle-back Wax*, among the yellow-podded sorts, and *Red Valentine* and *Stringless Green Pod*, among the green-podded, were sorts of high excellence.

SUMMARY OF VARIETIES.

The following among wax sorts are recommended for general culture, *Valentine Wax*, *Keeney's Golden Wax*, *Cylinder Black Wax* and *Flageolet Victoria*. Green-podded sorts, *Red Valentine* and *Stringless Green Pod*. *Dwarf Horticultural* is an excellent shell bean.

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BEETS.

Variety.	Seedsman.	Date edible.	Remarks.
Columbia	Burpee	July 10	Five to six inches diameter, round, regular, rich color.
Crimson Chief	Johnson & Stokes	" 20	Four to five inches diameter, dark crimson, hard and firm, quality not best.
Detroit Dark Red	Ferry	" 14	Excellent specimens of the class; good form, color and quality.
Dirigo Blood Turnip	U. S. Dept. Agr.	" 16	Dark flesh, firm and sweet, not crisp or tender, form irregular.
Dobbie's New Purple	Dobbie & Co	" 20	Long Blood class: good form and color: watery, quality not best.
Electric	Henderson	June 24	Regular form, color light, not of high quality.
Landreth's Very Early	Landreth	" 23	Fine form, flesh nearly white, color against it.
Long Blood Red	Landreth	Aug. 5	Excellent specimens of class.
Shull's Model Blood Turnip	Buist	July 10	Perfect form, flesh very firm, crisp, sweet and tender, bright crimson.
Stinson Dark	Burpee	" 10	Good form, very dark, firm, flesh of good quality.
Surprise	Johnson & Stokes	June 15	Not of regular form, flesh white, sweet, not very solid or crisp.
Egyptian Turnip Rooted	John S. King	" 20	An improvement over old Egyptian.

The varieties of beets were planted May 18. When the roots were from two and one-half to three inches in diameter they were taken to be of edible size, and the dates given in the table above.

Surprise was earliest to mature, but the color and quality are not of the best. Its earliness, however, is a strong point in its favor.

Egyptian Turnip Rooted. John S. King, England. Early.

It seems to be an improvement in form, firmness and quality over old type of Egyptian.

Columbia is a little earlier than the Blood Turnip sorts, and equal to them in form and quality. A very desirable sort.

Shull's Model Blood Turnip was perfect in form, very firm flesh which was crisp and tender. Its fine form, quality and earliness make it one of the best of the Blood Turnip beets.

Long Blood is an excellent sort for winter use.

Egyptian or *Eclipse* for first early, *Bassano* for greens, *Shull's Model Blood Turnip*, or any of the Blood Turnip class with *Half-long* or *Long Blood* would give an excellent list of varieties for the garden or for market.

CABBAGE.

Sixty-eight varieties were selected for the test in cabbages.

The seed of the early sorts was sown in small boxes in the forcing house, March 16; the medium varieties were sown April 23, and the late ones May 19.

As soon as the third leaf appeared on the seedlings they were pricked out into flats and allowed to grow until the time of transplanting in the field, when twenty-five plants of each variety were set in rows three and one-half feet apart.

The early varieties were put in the field May 18, the medium June 11, and the late ones July 3.

The early sorts were watered once by surface irrigation when the heads were about half grown, but the following rains furnished sufficient moisture to mature the crop. The early and medium varieties developed large and solid heads, but the wet weather retarded the growth of the late varieties and many failed to head, hence comparisons were not put in the table.

They were planted in rows three and one-half feet apart, each plant having a space of twenty inches in the row.

CABBAGE.

Number.	Variety.	Seedsman.	Season.	Date. First mature head.	Date. Market maturity.	No. days from transplanting to maturity.	Number plants headed.	Total weight.	Average weight.
1	All Head	Burpee	Early	July 20	Aug. 5	79	19	57	3
2	Brunswick Improved	Vaughan	"	" 29	" 6	80	18	36	2
3	Bullock Heart	Landreth	"	" 17	" 3	77	20	66	3.3
4	Dwarf Flat Dutch	Landreth	"	" 20	" 2	76	9	18	2.
5	Earliest	Johnson & Stokes	"	" 20	" 3	77	18	60	3.3
6	Etampes	Ferry	"	" 16	" 3	77	21	57	2.71
7	Express	Vaughan	"	" 17	" 3	77	16	455	2.[illegible]
8	French Ox Head	Henderson	"	" 28	" 5	79	9	21	2.3
9	Hend. Early Spring	Henderson	"	" 18	" 3	77	12	42	3.5
10	Henderson Early Summer	Henderson	"	" 28	" 6	80	15	36	2.4
11	Landreth Earliest Market	Landreth	"	" 21	" 3	76	15	49	3.26
12	Bloomsdale	Landreth	"	" 23	" 6	80	10	28	2.8
13	Reedland Drumhead	Landreth	"	" 23	" 6	80	19	66	3.47
14	Reynolds	Gregory	"	" 24	" 6	80	6	17	2.87
15	Salzer's Lightning	Salzer	"	" 7	" 3	77	17	70	4.11
16	Scotland Early	Burpee	"	" 25	" 6	80	13	32	2.46
17	St. John's Drumhead	Henderson	"	" 24	" 6	80	11	30	2.72
18	Summer Flat Head	Landreth	"	" 22	" 5	79	8	28	3.5
19	Wakefield, Early Jersey	Vaughan	"	" 20	" 5	79	22	70	3.18
20	Wakefield, Early Selected	Vaughan	"	" 14	" 3	77	17	70	4.11
21	Wakefield, Charleston	Henderson	"	" 21	" 5	79	21	78	3.71
22	Wakefield, Large Jersey	Vaughan	"	" 17	" 5	79	16	55	3.13
23	Wakefield, Prize	Maule	"	" 18	" 5	79	20	74	3.7
24	Wakefield, Washington	Northrup, Braslan, Goodwin & Co.	"	" 17	" 5	79	16	64	4
25	Winnigstadt	Ferry	"	" 23	" 6	80	11	39	3.54
26	Wonderful	Johnson & Stokes	"	" 17	" 3	77	15	56	3.73
27	York Early	Henderson	"	" 29	" 10	81	9	18	2
28	York Early	J. Kling	"	" 29	" 10	81	16	56	3.5
28½	All The Year Round	Landreth	Medium	Aug. 15	" 25	75	15	106	7.06
29	All The Year Round	Johnson & Stokes	"	" 10	" 20	70	21	84	4
30	Braunschweiger	Salzer	"	" 18	" 23	73	12	71	5.91
31	Eclipse	Maule	"	" 28	Sept. 1	81	5	27	5.4
32	Long Island	Brill	"	" 10	Aug. 20	70	21	172	8.19
33	Lupton	Burpee	"	" 17	" 28	78	23	161	7
34	Lupton	Maule	"	" 17	" 28	78	15	165	11
35	Midsummer	Maule	"	" 18	" 25	75	23	184	8
36	Salzer's Ideal	Salzer	"	" 18	" 26	76	20	146	7.3
37	Short Stem	Henderson	"	" 16	" 24	74	19	157	8.26
38	Succession	Henderson	"	" 10	" 20	70	17	133	7.81
39	Vandergaw	Vaughan	"	" 30	Sept. 1	81	21	202	9.61
40	World Beater	Burpee	"	" 19	" 1	81	23	110	4.74

The table includes many kinds that have been on trial for several years, some of which show special value and were grown for the purpose of comparison.

Among the standard early varieties are Salzer's Lightning, the Wakefields, Henderson's Early Summer, Bloomsdale Early Market and Early Flat Dutch. All are of value for the production of early solid heads of good size, shape and quality.

For medium varieties there are none better than Succession, All Seasons, Reynolds, and the Early Drumheads, some of which produce heads equal in size and quality to some of the winter varieties.

The Drumheads, Flat Dutch and Rock Heads stand at the head as winter cabbages in size, firmness, flavor and keeping qualities.

NOTES ON VARIETIES.

The following notes are given on some of the newer varieties that appear to be of merit:

Early.

Bullock Heart, from Landreth, was one of the first to develop mature heads. The plants are small; stems short and stout; foliage, light green and grows many superfluous leaves. Outer leaves are smooth, thick, erect, glazed; head conical, very solid. The type is similar to that of Wakefield and it is a valuable sort, being a strong, quick grower.

French Ox Head, from Henderson, is a variety maturing a little later than Brunswick Improved; heads were small, soft and not true to any type.

Henderson's Early Spring is a valuable early sort, of the type of Henderson's Early Summer, but a little smaller. The plants are small; stem, short and stout; leaves, dark green, oval, smooth, a little glazed and few in number. Heads are of medium size, flat, round and hard.

Reedland Drumhead.—Landreth. The plants are large, strong growers heavily covered with white bloom. It is a short stemmed, flat headed second early sort; heads are surrounded with much superfluous foliage, but are very hard and compact. True to type.

Scotland Early, from Burpee, is a variety that resembles the Wakefield but is not as desirable. The plants were strong; leaves large, oval, with undulate border; bloom, thin; heads of fair size, true to type, but not very hard, and surrounded with a large amount of superfluous foliage.

Summer Flat Head, from Landreth. Not true to type; appears to be badly mixed in the seed; some good heads but it showed no distinct type as to growth, size, shape or color.

Prize and *Washington Wakefields*, from Maule and Northrup, Braslan and Goodwin, are much alike. They are of the type of the Early Jersey Wakefield, but seem to be a few days later. Plants of medium size; stem, short and stout; leaves, small, dark in color, oval or spoon shaped; heads conical and very solid, with very few surplus leaves. Both are valuable early varieties, being strong growers and sure headers.

Wonderful, from Johnson & Stokes. The plants are very small, with short, slim stems; foliage compact, smooth, dark green and numerous outside leaves; heads, conical, good size, but rather loose. Its special value as an early sort is that it can be grown very close and develops rapidly.

Medium Varieties.

Among the medium varieties, those of special value are as follows:

All the Year Round, from Landreth. This cabbage is about ten days later than the Early Drumhead varieties. Plants are medium size; stem, short and strong; heads, very solid, large and flat; leaves, dark blue, very thick and leathery, but no amount of extra foliage. As the name might indicate, it is a valuable medium or late variety.

Braunschweiger (Salzer), is one of the leading varieties for pickling. The heads are very large, compact, tender and juicy; stem, short and stout; foliage, light green with purple border. It has more superfluous leaves than *All the Year Round*, and is a little glazed.

Long Island, from Brill, resembles the *Lupton* but is not true to type, hence of no special value.

Lupton, from Burpee, was originated in 1888 by J. M. Lupton, one of the most successful cabbage growers on Long Island. The plants are large; heads, thick, flat, hard, crisp and juicy, and are nearly covered by the outside leaves overlapping them. The leaves are of dark bluish green color with purple border, and well filled to the union with the stem. A valuable medium variety for its size of heads, vigor of plants and general high qualities.

Midsummer, from Maule's seed house, developed the largest per cent of solid heads of any variety in the test. In shape, form and type it resembles *All the Year Round*. The plants were large and vigorous, developing enormous heads that were solid, white, crisp and juicy; stem short and stout; foliage thick, light green with white bloom, growing but a very few outside leaves. This being such a sure header, it promises to be of value to the commercial gardener.

Salzer's Ideal, Salzer, grows a symmetrical flat shaped head, and is uniform in size. The heads are solid, crisp, on a short stem, well covered with light green foliage tinted with white bloom. The heads have very few extra leaves and are not as large as Lupton.

Short Stem, Henderson's, is a variety that is true to type and a valuable cabbage for medium or late use. It grows a little smaller than *Midsummer* but is a sure header and identical with it in quality.

Succession is one of the standard varieties and showed a large per cent of developed heads. It is about two weeks later than the *Early Summer* and is all its name implies. The heads are large, flat, thick, very solid and crisp; stems short and stout; foliage medium light with blue white bloom. True to type and valuable for a medium or late crop.

World Beater, Burpee's, stands with *Midsummer* and *Succession* for per cent of heads matured. The foliage is broad, compact, dark green with brown tints; very true to type, developing firm, crisp heads of fine quality.

Late Varieties.

Market Gardener's Flat Dutch, Landreth, grows a large, vigorous plant with a short, stout stalk. The foliage is compact, medium, dark green with red and purple border; heads large, broad, flat, thick and solid, encased by the leaves overlapping each other. True to type and a desirable variety.

Northrup, Braslan, Goodwin and Company's *One Hundred Weight*, and Johnson and Stokes' *Rock Head* are identical, true to type, and developed

a good per cent of heads, the same shape and quality as *Flat Dutch*, but not as valuable, lacking in size.

Red Drumhead, from Ferry & Co., of Detroit. The principal value of this variety is its shipping qualities. It is a vigorous grower, producing round, hard heads; foliage, thick, red, with white bloom. A valuable sort for market gardeners owing to its vigor, hardiness, size and weight.

Two varieties of *Netted Savoy*, from Henderson and Johnson & Stokes, were of the same type and growth. The plants were of medium size, short stem and vigorous growers; heads solid, compact and elliptical in form; foliage yellow, with green tint. Not of special value, although by some they are admired on account of their delicate flavor.

Champion Drumhead, J. Kling, Essex, England. The Drumheads are the largest growing varieties of cabbage, producing large, broad, deep, hard heads of high quality and should be grown in every garden for a winter sort, as they are sure headers and good keepers.

The varieties of Chinese and Siberian cabbage grown proved to be different kinds of mustard and were of no value.

KALE AND KOHL RABI.

Four varieties of Kale were grown, *Curled Scotch, Dwarf Moss, German Dwarf Purple and Green Scotch Curled*, the seed of which was all obtained from D. M. Ferry & Co., Detroit.

The *Curled Scotch* is a light green, dwarf spreading variety, reaching under good treatment a diameter of three feet. The leaves are very curled on the border and of a mild, sweet flavor when cooked. Greatly admired by some people for salads, and is grown for greens during the winter, as it will endure a low temperature without injury.

Dwarf Moss is a very close curled, green variety, growing a little taller than *Curled Scotch*, but not as spreading, averaging about twenty-four inches in height.

German Dwarf Purple is a very attractive variety; low growing, spreading to a diameter of three to four feet; fine curled and of a rich purple color. Not as sweet flavor as the green sorts but more attractive.

Green Scotch Curled is a tall growing sort, often reaching three to four feet in height. Not as spreading as the dwarf kinds and leaves are not set as close on the stalk. Of mild flavor and very tender.

KOHL RABI.

Seed was obtained from D. M. Ferry & Co., of two varieties of Kohl Rabi, the *White* and *Purple Vienna*, which differ only in color. They grow a large bottom, smooth, having but few leaves and small roots. A choice vegetable for many people when cooked and eaten the same as cabbage.

CUCUMBERS.

The cucumbers were planted June 2. The following table gives the varieties planted and the dates when the fruits were of pickling size and when ready for slicing.

CUCUMBERS.

Variety.	Seedsman.	Date of pickling size.	Date of slicing size.
Albino	Ferry	Aug. 3	Aug. 8
Cluster—Early	Ferry	July 21	July 27
Commercial Pickle	Thorburn	July 29	Aug. 5
Cool and Crisp	Ferry	July 31	Aug. 3
Emerald	Childs	Aug. 4	Aug. 10
Eskimoso	Johnson & Stokes	July 19	July 24
Green Prolific	Henderson	July 24	July 29
Long Green	Ferry	Aug. 3	Aug. 10
Market Garden	Salzer	Aug. 1	Aug. 6
Persian	Salzer	July 26	Aug. 1
Prolific Pickle	Salzer	July 27	Aug. 1
Russian Early	Ferry	July 23	July 27
Short Green	Ferry	July 26	July 31
White Spine—Arlington	Vaughan	July 28	Aug. 1
White Spine—Early	Ferry	July 29	Aug. 3
White Spine—Evergreen	Johnson & Stokes	July 29	Aug. 3
White Spine—Fordhook	Burpee	July 29	Aug. 3
White Spine—Monarch	Buckbee	Aug. 1	Aug. 8
Japan No. 1	Oregon Agricultural College	Aug. 1	Aug. 7
Japan No. 2	Oregon Agricultural College	Aug. 3	Aug. 9
Climbing No. 4	Oregon Agricultural College	Aug. 6	Aug. 14
Chinese	Oregon Agricultural College	Aug. 3	Aug. 10

NOTES ON VARIETIES.

Albino is late, but the plants are strong growing and productive. It is an excellent sort to furnish small, white pickles. The variety is also good for table use because of its delicate flavor. A most desirable white sort for pickles or table use.

Emerald. The plants are of strong growth but scarcely so productive as many others. Fruits much the shape of *Arlington White Spine*, but later in maturing and without spines. Color, a rich, light green. An excellent sort for large, late pickles and for slicing purposes, because the fruits remain a long time in condition before ripening.

Eskimoso. Plants are of small growth and fruits are borne close to hill. The fruits closely resemble Russian in form, but the season is several days earlier. Excellent for small, early pickles, because of the firm flesh, its excellent quality and the late development of the seeds; also one of the best early slicing sorts.

Market Garden is one of the best slicing sorts on account of the strong growing, very productive plants, and its length of season for producing fruits.

Persian lacks quality. Is of no practical value.

Commercial Pickle is a good sort to grow for small to medium-sized pickles.

Cluster was the first variety to produce fruits suitable for slicing. As an early slicing sort it has a place.

Green Prolific, because of its great productiveness ranks among the first sorts for general pickling purposes.

Long Green. The merits of this variety for late pickles and for table use are well known.

White Spine. There are several strains of this well-known sort differing slightly in plant growth and form or color of fruit. All are good. This variety is the best medium season, general purpose cucumber.

Cool and Crisp closely resembles the White Spine class.

Japan No. 1 and No. 2. The seed of these sorts came from Japan. The plants are of strong, healthy growth, but less productive than most others grown. The fruits were of good size and form, and possessed a flavor distinct, but not unpleasant. No. 2 was later than No. 1 and better in quality. These sorts are inferior to our well-known varieties.

SUMMARY OF VARIETIES.

The following sorts are recommended for the purpose named:

For early pickles—*Russian.*

For early slicing—*Cluster.*

For early slicing and pickling—*Eskimoso.*

For general pickling—*Commercial Pickle* and *Green Prolific.*

For table use— *White Spine* and *Long Green.*

If a white sort is desired *Albino* would give satisfaction.

LETTUCE.

The forcing varieties were started early and the plants placed in hotbeds to test their adaptability for that purpose.

Tennis Ball forms very compact heads of medium size. The outer leaves are dark green, while the head is quite light in color, tender and of best quality. It matures quite early and was the best close heading sort in the beds.

Silver Ball is not so close heading as the preceding, the leaves are lighter green and tipped with white. The heads are attractive in appearance and their quality of the best. Scarcely so large as *Tennis Ball*, but a little earlier in maturing.

Sensation. A little later in maturing than *Silver Ball;* closely resembles that variety, but its leaves are more waved, heads more loosely formed, and it is scarcely so good in quality.

Boston matures about the same time as *Silver Ball;* heads a little larger, deeper yellow in color and less compact. Of longer season than *Silver Ball* and an excellent forcing sort.

Hubbard Market. A few days later than *Tennis Ball* and closely resembling that sort, but the heads are larger and not so close.

White Star. A large, loose heading sort, closely resembling *Black-seeded Simpson*, but earlier in maturing. It has a long season, and is one of the best large, loose heading sorts for forcing in hot-beds.

Buttercup forms close heads of a beautiful yellow color and of fine quality. It is not a quick growing sort.

Market Gardener's Forcing forms a large, loose head. The leaves are light green in color, considerably curled. It is a quick grower and stands heat well. Much like *Grand Rapids.*

Silesia. An upright, loose grower; does not form a head. An excellent sort to grow for early cutting, as the leaves may be cut when quite small.

Landreth Cutting. Manner of growth quite like *Silesia*, but the leaves are smaller and it is a quicker grower.

LETTUCE OUT OF DOORS.

Plants of the varieties above mentioned, together with twenty other sorts, were transplanted to the open ground May 6. The data given in the table below were obtained from this planting.

LETTUCE.

Variety.	Seedsman.	Date of maturity.	Average weight of a single head.
Black Seeded Butter	Ferry	June 15	14 oz.
Boston	Ferry	" 15	1 lb. 3 oz.
Blonde Beauty	Vaughan	" 18	1 lb. 13 oz.
Bloomsdale Reliable	Landreth	" 10	6½ oz.
Brown Dutch	Ferry	" 18	13 oz.
Buttercup	Ferry	" 10	10½ oz.
Deacon	Ferry	" 13	14 oz.
Denver Market	Ferry	" 15	1 lb. 1½ oz.
Drumhead Cabbage	Ferry	" 14	9 oz.
Dwarf White Heart	Burpee	" 20	1 lb. 3 oz.
Frankfort Head	Ferry	" 13	9 oz.
Hanson	Ferry	" 15	1 lb. 7½ oz.
Hubbard Market	Ferry	" 13	9½ oz.
Iceberg	Vaughan	" 15	1 lb. 15 oz.
Landreth Cutting	Landreth	" 12	10½ oz.
Largest of All	Landreth	" 18	1 lb. 6 oz.
Market Gardener's Forcing	Ferry	" 10	8 oz.
Market Gardener's Private Stock	Ferry	" 14	9½ oz.
Mignonette	Henderson	" 10	15 oz.
Morse	Burpee	" 14	1 lb. 11 oz.
Ninety and Nine	Vaughan	" 11	8 oz.
Philadelphia Butter	Ferry	" 8	5 oz.
Prize Head	Ferry	" 12	1 lb. 1½ oz.
Sensation	Johnson & Stokes	" 14	15 oz.
Silesia	Ferry	" 18	1 lb. 8 oz.
Silver Ball	Ferry	" 12	11 oz.
Simpson Curled (black seed)	Ferry	" 13	1 lb. 10 oz.
Simpson Curled (white seed)	Ferry	" 15	1 lb. 9½ oz.
Sunset	Henderson	" 15	1 lb. 2½ oz.
Tennis Ball	Ferry	" 11	11 oz.
Tilton White Star	Ferry	" 15	1 lb. 7 oz.

Iceberg. This sort forms a very large head, quite close and compact. The outer leaves are a purplish green, lighter at tips, and curl over to protect the head from sun and to blanch it, making it tender and of best quality.

The heads remain in edible condition a long time before sending up a seed-stalk. A very valuable sort for garden use.

Morse. A lettuce of Simpson type, but it is a larger and better grower and stands heat better. Promises to be an acquisition in the garden as well as under glass.

Dwarf White Heart is a most excellent Cos variety, blanching well and of best quality and long standing.

Hanson, Blonde Beauty, Simpson and *White Star* are large growing, loose heading sorts, excellent for outdoor planting.

Prize Head. If one desires a dark-colored, purplish green lettuce of fine texture and long standing quality, this sort would be satisfactory.

Mignonette quite closely resembles Prize Head, but is earlier and forms a smaller, closer head.

ONIONS.

The experimental list of onions included twenty-nine American, one Siberian, one Mongolian and three Japanese varieties.

The excessive rains of the season retarded the growth of the American sorts and prevented their maturing; but the others were entirely drowned.

The *Bermuda* onions are gaining great popularity for quick growth, and large well formed bulbs.

The *Red* and *White* differ only in color, both having a thin skin, crisp flesh and mild flavor.

Bountiful, from Landreth, is a medium-sized, globular onion, with yellow skin and white, tender flesh.

Danvers Yellow, from D. M. Ferry. One of the standard varieties for commercial or domestic use, producing a round, firm bulb of good flavor, and fine keeping qualities. By a careful selection of seed of the Globe type a distinct form has been obtained called *Globe Danvers,* but the quality, texture and flavor are the same.

Extra Early Red, from Ferry, is much like Bermuda Red, of medium size and flat; very prolific and uniform in shape and size. A good, early market variety.

Gigantic Gibraltar, Burpee. The Gibraltar is very similar to Prizetaker, but more globular and of lighter color. It is a very fine looking onion, straw colored skin, white crisp flesh and very mild flavor.

The *Southport Globes, Red, White* and *Yellow,* also *Michigan Yellow Globe,* are varieties that need no description, as nearly every gardener's list includes them. They are all good shaped, prolific and mild-flavored varieties. The seed was obtained from D. M. Ferry & Co.

Golden Ball and *Ivory Ball,* from Johnson & Stokes, are two varieties that belong to the Globe class. They have respectively a bright yellow and pure white tender skin, snow-white, tender flesh and mild flavor. They are among the best keepers.

Gold Seal, from Landreth, is an early variety, resembling Extra Early Red, except in color, which is a bright yellow. A desirable early sort.

Golden, from Landreth. This is a very round variety, rich in color, much like the Danvers, but larger, harder and a better keeper. This seems to be a desirable acquisition for the market gardener's list or as a domestic variety.

Italian, from Ferry & Co. The white Italian onions embrace several varieties, viz.: Marzajola, Queen, Rocca, Silver King and Portugal, all being of good size, pure white, tender and good flavor.

These varieties, if sown thickly, produce fine pickling onions; but if sown very early in hot-beds, or under glass, and then transplanted, they will grow into large, delicious flavored bulbs.

Prizetaker. D. M. Ferry & Co. One of the standard varieties that needs no description.

The outside skin is rich purplish yellow; flesh, very white, tender and mild flavored; solid and a good keeper.

This is one of the best varieties for starting under glass and transplanting; much work in that line was done this season with satisfactory results.

Prizewinner, from D. M. Ferry, is an exact duplicate of Prizetaker, except in color, which is a pure white.

Every gardener should grow one of these varieties.

Silverskin, Round White, from D. M. Ferry, is a valuable early sort, as it grows very rapidly, and is extensively used for bunching.

It is very white, firm, crisp and mild flavored.

Strasburg, from Landreth. This leading yellow variety is globe shaped and of medium size, with a thin skin, and very tender, mild flavored flesh.

Wethersfield, from D. M. Ferry. Among the red onions this is the variety most commonly grown. It is very prolific, large, and considerably flattened; flesh, purplish white, fine grain, crisp and tender, but not as mild flavored as some others. A good keeper and shipper.

Yellow Dutch, from D. M. Ferry is nearly identical with Yellow Danvers, but is a little later. A good grower and shipper.

Zittan Giant, from Ferry, is a very large, yellow onion of superior quality.

PEAS, 1896.

The thirty-four varieties of peas grown this year included several of the older standard sorts, and the new ones sent out as novelties by the different seedsmen.

The object was not to see how many varieties could be grown, but to determine which are of superior merit, and if any of the new sorts are some old varieties renamed, thus aiding the grower in selecting only desirable kinds.

The seed was sown April twenty-seventh, in double rows, the drills being four inches deep, and twelve feet long, using about one seed to each two inches, or one hundred and forty-four for each variety.

Heavy rains followed immediately, and packed the soil, preventing many of the sprouts from coming up and causing others to rot.

The varieties Crown Prince, New Life, Nott's Excelsior, Renown, Nott's No. 961, and Telephone seemed to be most injured, and showed the smallest per cent of seeds germinated.

The rains which followed during the season afforded an abundant supply of moisture and a good crop was grown.

The Alaska reached edible maturity June 13, thus being the earliest variety.

Peas may be divided into seven distinct classes, as follows, viz.:

CLASS I.—Plants tall, exceeding four feet; seeds white or cream colored; pods curved.

Black-eyed Marrowfat. Plants four to five feet high, branching at base but very slender. Foliage dark green, stipules large; pods light green, strictly canoe shaped, and blunt at apex, containing six to seven spherical moderately sweet peas; very similar to the old White Marrowfat, but differing in having a curved pod, and a round, dark brown spot on that part of the seed called the hilum; a little later coming to maturity.

900 to 1. A new variety put out by Landreth, with vines four to five feet high; foliage light green; stipules large; pods slightly curved and very pointed at apex; small in size but containing seven to eight very plump, round peas, with a sweet, rich flavor. It promises to be a valuable variety.

CLASS II.—Plants tall, exceeding four feet; white or cream-colored seeds, curved pods.

Champion of England, a true type of this class, is one of the oldest varieties, and is extensively grown for late commercial and domestic purposes.

Giant-podded Marrowfat. A new variety sent out by Johnson & Stokes this season. Plants three and one-half to six feet high, branching at base, with stout stems; foliage dark green; pods dark green, large, broad, straight, blunt at apex, and three to four inches in length; peas large, round, flattened a little when old; sweet; generally six to eight in each pod; season late; quality fine. It mildewed badly or would be considered equal to Champion of England.

Telegraph and *Telephone* are two varieties that belong to this class. They are very similar, and differ from Champion of England in being shorter and several days earlier.

The pods are large and plump, containing five to eleven sweet, highly flavored peas. They are excellent medium late, wrinkled sorts.

CLASS III.—Half dwarf varieties, two to four feet high. Peas smooth or slightly indented; white or cream colored; pods straight, or nearly so.

Ferry's Extra Early is a good type of this class, and is nearly identical with the old variety Daniel O'Rourke.

The vines are two to three feet high, and are quite vigorous and productive. Foliage dark; pods dark, good size, broad, blunt at apex, usually five to six plump, round, sweet peas in each.

In quality this variety equaled Daniel O'Rourke, but did not show quite as large a per cent of peas.

Eugenie. Introduced by Landreth. Vines three to four feet high; foliage dark; very prolific; pods medium size, light colored and canoe shaped; peas four to eight in each pod, sweet and tender. Would not recommend it as a commercial variety, fearing that it would not endure a drouth, as the vines are very spindling.

Horsford's Market Garden, from Ferry, and *Market Gardener's Second Early,* from Johnson & Stokes, are almost identical with Bliss Everbearing, differing only in having larger and darker-colored vines. The vines are two and one-half to three feet high and very productive. Foliage very dark. Pods straight, plump, smooth, blunt at apex. Peas, round, sweet, tender, and four to seven per pod. A good variety for second early.

New Life.—A new variety from Gregory. Vines two and one-half feet high, strong growers; foliage, dark green; very prolific. Pods long, straight and broad, containing from five to eight sweet-flavored peas. This variety

and *Shropshire Hero* resemble an Improved Stratagem and are desirable acquisitions to a gardener's list for second early. They are very productive and of superior quality.

CLASS IV.—One-half dwarf; seeds blue or bluish-white; pods straight.

Dwarf Sugar, recommended by Landreth, is the sole representative of this class. Vines strong, vigorous growers, two to two and one-half feet high. Foliage, light green; pods, long, straight, blunt at apex, with indentations marking the location of peas. Peas, very sweet, averaging six to ten per pod. The pods are edible and are used the same as string beans. A very promising variety, prolific and of high quality.

CLASS V.—Vines half dwarf; seeds green, bluish-green, white and cream colored; seeds shriveled. Type, Alaska.

Alaska. From D. M. Ferry. Vines, two and one-half feet high, vigorous, strong growers. Pods, good-sized, containing four to seven large, sweet peas. The Alaska is very prolific and reached edible maturity several days in advance of Daniel O'Rourke and other early sorts.

Crown Prince. A variety introduced by Johnson & Stokes. Vines two to three feet high, foliage dark green. Vigorous growers, very prolific, in pods containing four to seven large, plump, sugary peas. This promised to be equal to Alaska but did not mature quite as evenly.

Daisy. Sent out by J. J. H. Gregory. Very few seeds germinated. Vines strong and vigorous, with dark green foliage. Pods large, plump, smooth, containing six to ten sweet, tender peas. It matured all its pods on the same day.

Echo Disseminated by W. A. Burpee. Vines two to three feet high; foliage very dark green; pods long, broad, some glaucous. Peas large, oval to spherical, tender and sweet, averaging six to seven per pod. Echo resembles Daisy, and they promise to be two valuable early sorts.

Bliss' Everbearing at one time was a leading variety but is now excelled by Alaska and other new sorts.

Hancock. Sent out by Gregory, and *Rural New Yorker*, from D. M. Ferry, were so nearly alike that no marked difference could be detected. Vines two to three feet high; foliage dark green; pods medium size, containing five to six peas, of fair flavor and texture, but inferior to Alaska and several other kinds.

Renown. Introduced by Burpee. Vines two to three feet high; vigorous, and dark green in color. Pods large, three to four inches long, slightly curved; peas plump, tender, sweet, averaging four to seven in each pod. It is well worth further trial.

Shropshire Hero, from Gregory, and *Stratagem*, from D. M. Ferry, are old varieties closely resembling each other, except that Hero is a little earlier. They are vigorous and prolific bearers of good flavored peas.

CLASS VI. Vines dwarf, one-half to two feet high, seeds green, bluish green, or cream colored; seeds much shriveled; pods straight, or nearly so.

Nott's Excelsior. Received from D. M. Ferry. This is a true type of the dwarf varieties. Vines nine to twelve inches high; vigorous, strong growers; foliage dark green; pods large, straight, and blunt at apex; peas plump, tender, very rich, averaging six to eight in a pod.

Nott's 961. Originated by Nott in 1895. The only difference between this variety and Excelsior is that it is a few days later and more productive, making it a valuable addition to the list of dwarf varieties. The quality is superior, not excelled in the earlier sorts.

Advancer. From D. M. Ferry. A variety growing a little taller than Excelsior, and two or three days later. Vines are dark green and vigorous in growth; not very prolific, but the peas are sweet, tender, and of fine form.

McLean's Gem and *Premium Gem*, both from D. M. Ferry, seemed to be much alike. Vines one to two feet high, vigorous and spreading; foliage dark green; pods light colored, two to three inches long, blunt at apex, containing six to seven plump, tender, sweet peas. The Gems stand foremost as second early varieties.

Tom Thumb Dwarf and *Tom Thumb Early*, from Ferry, are varieties appearing to be improvements on King of the Dwarfs. Vines eight inches high; vigorous growers; foliage dark green; pods straight, blunt, containing three to seven peas of superior quality. The only difference between the two sorts is that the Early seemed to be more prolific. Both are good varieties of this type, but not as prolific or of as fine quality as Excelsior.

CLASS VII.—Edible podded varieties:

French Sugar. One of Landreth's new varieties. The plants are very strong, about four feet high, branching at the base. Foliage light green; pods, broad, long, blunt at apex and slightly indented between the seeds; each containing from four to eight round, plump, sweet peas.

Melting Sugar. Sent out by Ferry. Vines strong, vigorous growers, with dark foliage and light-green pods; pods broad, blunt at apex and short, containing only four to six sweet-flavored, tender peas.

PEAS.—LIST OF VARIETIES.

No.	Variety.	Seedsman.	Per cent grew.	Date first blossom.	No. days from planting to edible maturity.	Length of edible maturity. Days.	No. of peas in each pod.	Per cent of peas to total weight.
1	Advancer	Ferry	75	June 2	54	12	6-7	38
2	Alaska	Ferry	98	May 25	47	14	5-6	35
3	Asparagus	Burpee	80	June 2	54	7	4-5	28
4	Champion of England	Ferry	80	June 16	70	18	4-9	38
5	Crown Prince	Johnson & Stokes	2	June 17	81	5	4-7	41
6	Daisy	Gregory	16	June 4	61	20	6-10	37
7	Daniel O'Rourke	Ferry	97	May 25	50	16	3-6	36
8	Dwarf Sugar	Landreth	99	June 14	61	20	6-10	43
9	Echo	Burpee	85	June 16	71	12	6-7	42
10	Eugenie	Landreth	25	June 8	72	14	4-8	46
11	Everbearing (Bliss)	Ferry	90	June 16	72	12	3-6	37
12	Everbearing (Bliss)	Gregory	99	June 13	62	17	4-7	41
13	Extra Early	Ferry	95	May 26	50	16	4-5	33
14	French Sugar	Landreth	98	June 15	72	14	4-6	30
15	Gem (McLean's)	Ferry	92	June 6	52	13	6-7	30
16	Gem (Premium)	Ferry	94	May 30	52	12	5-7	33
17	Hancock	Gregory	98	May 26	50	18	6-7	30
18	Horsford's Market Garden	Ferry	92	June 15	62	9	5-8	39
19	Market Gardener's Second Early	Johnson & Stokes	94	June 11	68	17	4-7	48
20	Marrow (Giant Pod)	Johnson & Stokes	45	June 17	68	14	6	38
21	Marrowfat (Black Eyed)	Ferry	92	June 19	71	15	6-7	39
22	Melting Sugar	Ferry	65	June 12	67	9	4-6	27
23	New Life	Gregory	8	June 15	71	17	5-8	36
24	Nott's Excelsior	Ferry	9	May 30	52	8	6-8	40
25	Nott's 961	Nott	15	May 29	53	8	4-6	34
26	900 to 1	Landreth	98	June 16	65	9	7-8	48
27	Renown	Burpee	2	June 15	72	12	4-7	30
28	Rural New Yorker	Ferry	98	May 26	50	15	5-7	35
29	Shropshire Hero	Gregory	70	June 11	69	17	6-9	41
30	Stratagem	Ferry	25	June 16	71	15	6-11	39
31	Telegraph	Ferry	80	June 11	67	17	7	29
32	Telephone	Ferry	9	June 11	70	16	5-11	44
33	Tom Thumb (Dwarf)	Ferry	90	June 2	52	9	5-7	30
34	Tom Thumb (E'y)	Ferry	92	May 29	51	16	5-7	38

POTATOES.

One hundred and sixty-five varieties of potatoes were experimented with during the past season, including forty-eight new sorts sent out by leading seedsmen. The balance are some of the standard varieties that have been grown several years.

A few of the chemical fertilizers were used and some work was done along the line of irrigation; but owing to the excessive rains the results were such that no comparison could be made.

The land used for the early varieties is located near the northwest corner of the vegetable garden; it is a sand loam with a subsoil composed of clay mixed with a large per cent of quicksand.

Vines were grown on the ground last season and after they were removed it was heavily manured with fine compost, and plowed.

Early in the spring the ground was plowed and well worked with roller and Acme harrow, until, at the date of planting (May 16), it was a very firm, mellow seed bed.

The ground was marked with furrows three and one-half feet apart, and each variety was given forty feet of space in the row; two pounds of seed were taken for each sort and cut into forty pieces; one piece was used for each hill, making them twelve inches apart.

The seed was dropped by hand with the eye up, and covered about four inches.

After planting, the ground was rolled and on the fourth day it was worked with Breed's weeder, which loosened the crust and prevented the growth of any weeds.

This weeder was used once each week until the plants were from five to six inches in height, after which the Planet Jr. cultivator was used weekly or after every rain, until the vines covered the ground. Shallow cultivation was strictly adhered to, keeping the ground as level as possible.

The plot for the late varieties is located in the northeast corner of the vegetable garden, where the soil is much stronger in vegetable humus, and has a sand loam mixed with clay for a subsoil, which makes it more fertile than the soil in which the early varieties were grown. The preceding crop was potatoes, and the ground was treated the same as for the early sorts, and planted June second.

The same amount of seed, two pounds, was cut into twenty-five pieces, and given forty feet of space.

The planting and cultivating was conducted the same as with the early varieties.

The table of variety tests shows the results. The new varieties grown in the test this year were obtained from the following parties:

Peter Henderson & Co., 35–37 Cortland St., N. Y.—Uncle Sam and a variety numbered $2\frac{4}{3}1$.

Currie Brothers, Milwaukee, Wis.—Lakeside Champion, Snowflake Jr., Milwaukee.

B. W. Steere, Carthage, Ind.—Early Pinkeye, Extra Early Six Weeks Market.

W. H. Maule, Philadelphia, Pa.—Maule's Early Thoroughbred.

Edwin F. Dibble Seed Co., Honeoye Falls, N. Y.—Rose No. 9, Honeoye Rose.

John A. Salzer, Lacrosse, Wis.—Inability, Champion of the World.

Johnson & Stokes, Philadelphia, Pa.—Pride of the South, Table King.

A. E. Manum, Bristol, Vermont.—Enormous.

Herrick Seed Co., Rochester, N. Y.—Peachblow Seedling.

Geo. W. P. Jerrard Co., Caribou, Maine.—Country Gentleman.

J. M. Fluke, Nankin, Ohio.—Wise Seedling.

L. L. Olds, Clinton, Wis.—Vigorosa.

Fred E. Young, Rochester, N. Y.—King of Roses, Early Bell, Fottler's Peachblow.

Matthew Crawford, Cuyahoga Falls, Ohio.—Flagle.

E. H. Vick, Rochester, N. Y.—Puritan, Vick's Early Excelsior, Napoleon, Good News, Vick's Abundance, Irish Cobbler, Stump the World.

M. A. Crawford, Attica, Mich.—Michigan Beauty, Queen of the Field.

E. G. Saxton, Springport, Mich.—Vick's Early Pride, Orphans, Quick

Crop, Vick's Harvest Queen, Maggie Murphy, Farmer's Alliance, Rutland Rose, Sure Crop, White Mountain, American Beauty.

SUMMARY OF PROMISING VARIETIES.

The varieties that should rank among the standard sorts are mentioned in the following lists. Those marked with the star (*) grew in soil that lacked in fertility as compared with the late plot; which, together with the fact that the early varieties are lighter yielders, explains the reason of the noticeable difference in the output.

Early Varieties.

The varieties maturing first, and giving the largest yields, per acre, were Irish Cobbler (193.37 bu.) and Early Pride* (155.5 bu.), while Early Michigan* (155.8 bu.), Early Norther* (133 bu.), Early Pinkeye* (142.5 bu.), Early Walton* (150.31 bu.), Early Woodbury* (145.1 bu.), and Quick Crop,* with a yield of (134.76 bu.), were nearly as productive.

Medium Early.

Rose No. 9* (171.05 bu.), Early Bell* (145.13 bu.), are very promising medium sorts, and were closely followed by two varieties, Good News* (132.07 bu.) and Acme* (132.17 bu.), which are equal in quality and nearly as productive.

Medium Late.

Livingston Banner (425.03 bu.), Country Gentleman (388.75 bu.), Wise's Seedling (357.64 bu.), Napoleon (342.1 bu.), Lakeside Champion (336.91 bu.), Rutland Rose (331.73 bu.), and Inability (316.18 bu.), Rural New Yorker No. 2 (362.83 bu.), Supplanter (321.36 bu.), Troy Seedling (326.55 bu.), and Vanguard (383.56bu.), comprises the list of the medium late varieties.

Late Varieties.

Among the late sorts the heaviest yielders were, Enormous (502.78 bu.), and Champion of the World (425.03 bu.), but Fottler's Peachblow, yielding 352.46 bushels, Maggie Murphy (383.56 bu.), Carman No. 3 (300.63 bu.); Cayuga, (393.93 bu.), Great Divide (363.93 bu.), Hicks 22 (399.1 bu.), Hicks 101 (347.28 bu.), White Manhattan (404.3 bu.), White Prize (378.38 bu.), and World's Fair (336.91 bu.), are varieties of much merit. There are many other varieties that have been grown for several years and are reliable, notes and descriptions of which may be found in the previous bulletins.

TEST OF VARIETIES. 1896.

[Varieties marked with * were planted in the early plot.]

Variety.	Date of ripening.	Yield.			Total yield. 1895.	Average yield. 1895, 1896.	General average.	Number of years. Averaged.
		Bushels per acre. Large.	Bushels per acre. Small.	Bushels per acre. Total.				
Abundance	Sept. 22.	248.8	36.28	285.08				1
*Acme (Allen)	" 15.	132.17	31.1	163.27				1
*Acme (Dep't)	" 12.	109	33	142	275	218.5	165.66	3
*Adirondac	" 20.	134.73	31.1	165.83				1
Alexander Prolific	Oct. 10.	295.45	41.46	336.91	259.25	298.08	234.49	3
*Alpha	Sept. 15.	44.05	18.14	62.19	277.25	169.72	139.86	4
American Beauty	Oct. 10.	243.61	51.82	295.43				1
American Wonder	" 15.	25.91	10.36	36.27	379	237	200.65	5
*Beauty of Hebron	Sept. 20.	176.22	38.87	215.09	151	183.04	166.51	3
Bill Nye	Oct. 20.	77.75	41.46	119.21	179.5	149.35	143.24	5
*Bovee's Seedling	Sept. 5.	82.88	44.05	126.93	264.5	195.71		2
Breck's Chance	Oct. 5.	119.21	31.1	150.31	119.25	134.78		2
*Carman No. 1 (Dep't)	Sept. 30.	124.6	12.95	137.55	244.5	191.02	183.68	3
Carman No. 3 (Dep't)	Oct. 20.	300.63	25.91	326.54	280.25	303.39		2
Carman No. 3 (Hammond)	" 20.	207.33	20.73	228.06				1
Cayuga	" 25.	393.93	72.56	466.49	277.75	372.12	222.69	5
Champion of the World	" 28.	425.03	25.91	450.94				1
*Clay Rose	Sept. 15.	46.65	25.91	72.56	361.5	217.03		2
*Columbian Rose	Oct. 20.	46.65	36.28	82.93	252.75	167.84	220.42	4
Colorado Peachblow	" 20.	134.76	51.82	186.58				1
Country Gentleman	" 18.	388.75	67.38	456.13				1
Crown Jewell	" 18.	176.23	20.73	196.67	188	192.33	189.44	6
*Cyclone	Sept. 10.	88.11	33.59	121.7	266.5	194.1	131.4	3
Drouth Proof	" 10.	248.8	46.65	295.45	242	268.72		2
*Early Bell	" 26.	145.13	25.91	171.04				1
*Early Excelsior	" 25.	103.66	41.46	144.12				1
*Early Fortune	" 10.	88.11	33.69	121.9	226	178.9		2
*Early Market	" 8.	57.01	36.28	93.29				1
*Early Mayflowor	" 18.	80.34	25.91	106.25				1
*Early Michigan (Dep't)	" 1.	145.13	33.69	178.82	299.75	239.28		2
*Early Mich. (Hammond)	" 10.	186.6	36.28	222.88				1
*Early Minnesota	" 15.	77.75	26.91	104.66	133	118.83	128.27	6
*Early Norther (Dep't)	" 20.	98.43	12.95	111.38	287	199.16	189.08	4
*Early Norther (Allen)	" 10.	165.86	26.91	192.77				1
*Early Norther (Hammond)	" 12.	134.76	41.46	176.22				1
*Early Ohio	" 1.	108.85	31.1	139.95				
*Early Oxford	" 15.	88.11	31.1	119.21	187	153.10	155.15	3
*Early Peachblow	" 27.	129.25	10.36	139.94	333.5	236.72		3
*Early Peterson	" 26.	111.44	20.73	132.17	281.25	206.71	183.64	3
*Early Pinkeye	" 20.	142.54	15.55	158.09				1
*Early Puritan	" 22.	28.5	12.95	41.45				1
*Early Pride	" 1.	155.5	20.73	176.23				1
*Early Six Weeks Market	Aug. 25.	31.1	5.18	36.28				1
*Early Thoroughbred	Sept. 10.	101.07	31.1	132.18				1
*Early Walton	" 10.	150.31	15.55	165.86	326.75	196.3		2
*Early Wisconsin	" 18.	93.3	2.59	95.89	277	186.44	99.97	5
*Early Woodbury	" 28.	145.13	46.65	191.78				1
Eclipse	" 20.	25.91	10.36	36.27	140.25	176.52		3
Enormous	Oct. 28.	502.78	36.28	539.06				1
Farmers' Alliance	" 25.	253.93	20.78	274.71				1
Fillbasket	" 25.	207.33	36.28	243.61	396	319.8	203.52	5
Flagle	" 25.	238.48	31.1	269.58				1
Fottler's Peachblow	" 28.	352.46	41.46	359 92				1
*Freeman	Sept. 20.	108.85	12.95	121.80	370	245.9	191.04	6
*Gardner's Diamond	" 28.	111.44	12.95	124.39	343.5	233.94		2
General Purpose	Oct. 25.	259.16	62.2	321.36				1
Genesee Co. King	" 20.	31.1	10.36	41.46	285.5	163.48	163.69	5
*Good News	Sept. 20.	132.17	10.36	142.53				1
Governor Rusk	Oct. 25.	15.55	5.18	20.73	230.75	103 74	153.15	5

TEST OF VARIETIES.—CONTINUED.

Variety.	Date of ripening.	Yield.			Total yield. 1895.	Average yield. 1895, 1896.	General average.	Number of years Averaged.
		Bushels per. acre. Large.	Bushels per acre. Small.	Bushels per acre. Total.				
Great Divide	Oct. 28.	336.93	12.95	349.88	294.5	311.19	257.01	3
Halo of Dakota	" 2.	46.65	12.95	59.6	228	143.8	199.93	6
Harvest King	" 2.	243.61	20.73	264.34	329.25	296.79	----------	2
Harvest Queen	" 20.	295.45	46.65	342.10	----------	----------	----------	1
Heavy Weight	Sept. 30.	134.76	36.28	171.04	270	220.52	127.95	3
*Hicks' No. 12	" 1.	101.07	23.32	124.39	366.75	245.57	199.07	5
Hicks' No. 22	Oct. 18.	399.1	67.38	466.48	452	459.24	249.49	5
Hicks' No. 71	" 25.	67.38	10.36	77.74	273.5	175.62	190.99	3
*Hicks' No. 81	Sept. 10.	119.21	20.77	139.98	306.75	223.36	201.79	5
Hicks' No. 101	Oct. 26.	347.28	28.5	375.78	345.5	360.64	258.95	5
*Honeoye Rose	Sept. 15.	77.75	10.36	88.11	----------	----------	----------	1
Illinois Queen	Oct. 10.	88.11	7.77	95.88	134	114.94	140.87	3
Inability	" 12.	316.18	20.73	336.91	----------	----------	----------	1
Irish Cobbler	Sept. 5.	193.37	15.55	208.92	----------	----------	----------	1
Irish Daisy	Oct. 20.	20.73	7.77	28.5	365.5	197.5	105	3
Ironclad	" 25.	46.65	28.5	75.15	210.5	142 82	141.83	5
Joe Davis	" 20.	160.68	28.5	189.18	308.75	243.96	216.42	4
*June Eating	Aug. 25.	93.3	10.36	103.66	257.5	180.58	195.23	7
King of the Earlies	Sept. 10.	77.75	10.36	88.11	205.5	146.3	----------	2
*King of the Roses	" 25.	124.6	36.28	160.88	----------	----------	----------	1
Lakeside Champion	Oct. 15.	336.91	46.65	383.56	----------	----------	----------	1
Lazell's Seedling	" 17.	181.41	25.91	207.32	168.5	187.91	253.06	5
*Lightning Express	Sept. 26.	158.09	10.36	168.45	290	229.22	201.65	3
Livingston's Banner	Oct. 12.	425.03	2.59	427.62	----------	----------	----------	1
Maggie Murphy	" 28.	383.56	25.91	409.47	----------	----------	----------	1
Mammoth Pearl	" 10.	155.5	31.1	186.6	269.75	228.17	184.77	4
Main Crop No. 1	Sept. 28.	300.63	31.1	331.73	190	260.86	210.57	3
*Milwaukee (Dep't)	" 7.	93.3	15.55	108.85	310	209.42	178.5	3
*Milwaukee (Currie)	" 10.	93.3	10.36	103.66	----------	----------	----------	7
Michigan Beauty	Oct. 10.	95.89	23.35	119.24	----------	----------	----------	1
Money Maker	" 10.	207.33	36.28	243.61	245.25	244.43	----------	2
Mulia	" 12.	139.95	28.5	168.45	183.5	175.97	161.49	5
Muskrat Choice	Sept. 25.	20.73	5.18	25.91	240	132.95	121.97	3
Napoleon	Oct. 5.	342.1	88.11	430.21	----------	----------	----------	1
North Pole	" 20.	95.89	23.32	119.21	320	219.6	170.9	3
Northern Spy	" 25.	259.16	15.55	274.71	----------	----------	----------	1
O. K. Mammoth	" 20.	285.08	31.1	316.18	375.25	345.71	214.57	6
*On Top	Sept. 26.	93.3	10.36	103.66	393.25	248.45	187.73	5
One Hundred-fold	Oct. 22.	41.46	5.18	46.64	192.5	124.57	121.93	3
Oregon Pearl	" 18.	285.08	23.32	308.40	336.75	322.57	----------	2
*Orphans (Dep't)	Sept. 25.	132.17	10.36	142.53	345	243.76	----------	2
*Orphans (Saxton)	" 25.	119.21	15.55	134.76	----------	----------	----------	1
Paris Rose	Oct. 20.	46.65	36.28	82.93	333.5	283.21	187.38	5
Parker's Market	" 22.	161.11	15.55	206.66	229.5	218.08	----------	2
Park Region	" 18.	264.35	15.55	279.9	376.5	328.2	254.47	4
Peachblow Seedling	" 18.	409.48	25.91	435.39	----------	----------	----------	1
*Pearl of Savoy	" 12.	103.66	20.73	124.39	366.5	245.44	187.87	5
Potato, from Cordley	" 12.	176.23	31.1	207.33	----------	----------	----------	1
*Potato, from Peck	" 1.	41.46	10.36	51.82	----------	----------	----------	1
President Lincoln	" 25.	228.06	31.1	259.16	221	240.08	225.77	3
*Pride of the South	Sept. 10.	41.46	15.55	57.01	----------	----------	----------	1
Prize	Oct. 15.	290.26	36.28	326.54	306.5	266.52	----------	2
Prizetaker	Sept. 10.	109.96	7.77	117.73	326.5	222.11	193.52	3
*Queen of the Field	Oct. 12.	41.46	10.36	51.82	----------	----------	----------	1
Queen of Paris	" 12.	303.22	67.38	370.6	234	302.3	245.54	6
Queen of the White House	" 15.	176.23	20.73	196.96	341.25	269.1	----------	3
*Quick Crop	Sept. 1.	134.76	25.91	160.67	----------	----------	----------	1
*Reed's '86	" 1.	119.21	20.73	139.94	160	149.97	----------	2
*Reeves' Rose	" 20	51.83	7.77	59.6	218.5	1[illegible]9	129.3	3
*Restaurant	Aug. 28.	36 29	10.36	46.65	293.5	169.87	128.25	5
Rural N. Yorker, No. 2 (D'pt)	Oct. 1	362.83	41.46	404.29	204.75	3 4.52	193.18	7

TEST OF VARIETIES.—CONCLUDED.

Variety.	Date of ripening.	Yield. Bushels per acre. Large.	Yield. Bushels per acre. Small.	Yield. Bushels per acre. Total.	Total yield. 1895.	Average yield. 1895, 1896.	General average.	Number of years. Averaged.
B. N. Y. No. 2 (Ham.)	Oct. 1.	404.3	77.75	482.05	----------	----------	----------	1
Rochester Favorite	" 10.	202.33	20.73	223.06	208	215.53	206.13	3
*Rose No. 9	Sept. 20.	171.05	10.36	181.41	----------	----------	----------	1
*Rose Standish	Oct. 10.	145.13	31.1	176.23	----------	----------	----------	1
Rutland Rose	" 1.	331.73	67.38	399.11	----------	----------	----------	1
*Seneca Beauty	Sept. 20.	114.03	25.91	139.94	293.75	216.84	202.34	3
*Signal	" 1.	106.25	23.32	129.57	----------	----------	----------	1
*Sir William	" 25.	98.48	5.18	103.66	223.25	163.95	168.41	3
*Snowflake Jr. (Currie)	" 20.	145.13	10.36	155.49	----------	----------	----------	1
*Snowflake Jr. (Dep't)	" 20.	93.3	15.55	108.85	250	179.42	189.61	3
Somerset	Oct. 3.	62.2	7.77	69.97	204	136.98	----------	2
Stanley	" 20.	295.45	51.83	347.28	121.66	234.47	211.05	5
*Statesman	" 18.	88.11	2.85	90.96	236.5	163.73	137.98	3
Storrs' Seedling	Sept. 28.	31.1	10.36	41.46	118.5	79.98	109.98	5
*Summit	" 20.	124.4	20.73	145.13	434.25	289.69	252.16	7
Supplanter	Oct. 5.	321.36	20.73	342.09	192	267.04	217.01	6
*Table King	Sept. 25.	142.54	18.14	160.68	----------	----------	----------	1
*Telegraph	Oct. 1.	72.56	41.46	114.02	----------	----------	----------	1
*Telephone	Sept. 18.	67.38	36.28	103.66	240.25	171.95	237.04	4
Troy Seedling	Oct. 10.	326.55	20.73	347.28	252.5	299.89	208.45	5
Uncle Sam	" 1.	103.66	25.91	129.57	----------	----------	----------	1
$2\frac{4}{3}1$	Sept. 25.	165.86	15.55	181.41	----------	----------	----------	1
*Vanguard	" 24.	383.56	15.55	399.11	245	322.05	265.87	3
Van Ornam	Oct. 2.	134.76	10.36	145.12	262	203.51	----------	2
*Vaughan	Sept. 1.	72.56	25.91	98.47	300	199.23	164.11	4
Vick's Champion	" 30.	62.2	15.55	77.75	213.5	145.63	174.55	5
Vick's Harvest Queen	Oct. 1.	295.45	46.65	342.1	----------	----------	----------	1
Victor Rose	" 1.	181.41	31.1	212.51	315.5	264	211	3
*Vigorosa	Sept. 20.	103.66	20.73	124.39	----------	----------	----------	1
Watson Seedling	Oct. 10.	207.33	46.65	253.98	162	207.49	177.33	6
White Gem	" 1.	295.45	25.91	321.36	290	305.68	----------	2
*White Lily	Sept. 17.	77.75	20.73	98.48	205	151.74	----------	2
White Manhattan	Oct. 20.	404.3	36.28	440.58	294.5	367.54	----------	2
White Mountain	Sept. 30.	51.83	10.36	62.19	----------	----------	----------	1
White Prize	Oct. 15.	378.38	54.42	432.8	263	347.9	283.01	3
Wilson's First Choice	" 10.	332.88	41.46	378.37	315	346.68	----------	2
Wise's Seedling	" 10.	257.64	25.91	283.55	----------	----------	----------	1
World's Fair	" 15.	336.91	41.46	378.37	313.25	345.81	265.46	4
Woodbury White	" 15.	134.76	25.91	160.67	319.25	234.96	238.91	4
Wolverine Beauty	" 10.	129.58	28.5	158.08	216.5	187.29	178.06	4
Unknown (from Upper Pen.)	" 25.	362.83	7.77	370.6	----------	----------	----------	1
*Unknown (from U. S. Dept.)	Sept. 17.	93.3	10.36	103.66	----------	----------	----------	1
*Stump the World	" 1.	67.38	18.14	85.52	----------	----------	----------	1

NOTES ON VARIETIES.

Abundance.—One of the new medium late sorts, very productive. Size, medium to large; shape, oblong, flattened; eyes, large, shallow and open, with a pink tint around the sprout centers; skin, smooth, with a slight russet appearance; flesh, very firm, white and dry. Promises to be a valuable variety.

Adirondac.—Size, medium to large; shape, flat oblong; eyes, of medium depth, open and white; skin, white, smooth, with a very fine russet grain and a few small, white specks on the surface; flesh, of medium texture, a

little spongy, and cream tinted. A good yielder, growing very compactly in the hill. Vines, very strong and vigorous.

American Beauty.—This new variety is a strong grower and a productive late sort. Size, large; shape, oblong, somewhat flattened; eyes of medium depth, white and not numerous; flesh, pure white, firm and of good texture. This variety has the characteristics of a superior potato and is worthy of further trial.

Champion of the World.—Size, large, irregular, oblong in shape; eyes of medium depth, broad and open; skin, dark, coarse, russet; flesh, a little spongy and cream tinted.

Country Gentleman.—A very productive new variety. Size, medium to large; shape, oval to oblong, slightly flattened; eyes, broad, shallow and pink tinted; skin, russet, white, streaked with pink; flesh, firm, dry, light cream colored. Season, late. It has few superiors.

Early Bell.—One of the promising new varieties. Size, medium; shape, oval and slightly flattened; eyes, broad, shallow, partly closed, white; skin, white, covered with light colored specks; flesh, dry, solid, firm, of fine texture and very white.

Early Excelsior.—Size, medium to large; shape, oblong, flattened; eyes, broad, open, shallow, on body, but of medium depth on the seed end; skin, pink tinted, with fine russet appearance; flesh, dry, white, fine grained. A very promising new sort.

Early Market.—One of the varieties extensively advertised. Size, medium; shape, short, oval to round; eyes, shallow, broad, white; skin, light russet, netted; flesh, dry, white, firm, fine texture. A variety said to be earlier than the Ohio, but it was a week later this year, and it does not promise to be a heavy yielder.

Early Pinkeye.—A variety of recent introduction. Size, medium to large; shape, flat, oblong, a little irregular; eyes, shallow, broad, partly closed, pink tinted; skin, smooth, light pink; flesh, dry, firm, and white. Seems to be worthy of further trial, as it is very attractive in appearance.

Early Puritan.—This is a valuable early variety on account of its high quality. The tubers are long and pure white, which makes them very attractive. Eyes are very shallow, and the tuber is quite smooth; flesh, white, very dry and starchy, equal to the old variety, Snowflake, which had no superior in quality.

Early Pride.—A very strong growing variety, and considering its earliness, one of the most productive. The tubers are medium to large in size, smooth, having but few shallow, pink eyes, coming even with the surface. The flesh is very white, dry and firm, giving it points of superiority that makes it worthy of further trial.

Early Thoroughbred.—One of the new varieties strongly resembling the original Early Rose, equaling it in every respect. Tubers large, long oblong, very regular and slightly flattened. The eyes are of the Rose type, deep, numerous and pink colored, set in a smooth, clear pink and white skin. The flesh is very dry, firm, and of fine texture. Considering productiveness and quality it is a valuable variety for market or home use.

Enormous.—This gave the largest yield of any of the varieties, but was inclined to grow rough, which was probably caused by the wet, warm weather encouraging a new growth. Size, large, with small per cent of unmarketable potatoes. Shape, long oblong, rather irregular; eyes, numerous, deep, broad and open; skin, white with fine russet markings.

The flesh is very white, dry, solid and of firm texture. It promises to be a good keeper, and this, taken together with the productiveness, makes it a valuable acquisition.

Farmers' Alliance.—One of the new sorts of the Rose class, but the vines have a stronger growth. The characteristics of the tuber are about the same as those of the Late Rose. A good yielder and worthy of further trial.

Flagle.—A very large growing new sort with a bright pink, netted skin. Shape, flat oblong; eyes, deep, broad, with lip projecting over center of eye. Flesh very firm, dry and white. Will be given further trial.

Fottler's Peachblow.—It appears to be similar to the original Peachblow, and without superior qualities sufficient to enable it to supercede it. A large yielder of rough, irregular tubers, with dry, white, solid flesh.

Good News.—A round, oval shaped variety, with medium sized shallow eyes tinted with pink; skin, white, specked with light dots; flesh, of good color and fine texture. Quite attractive and medium in productiveness.

Honeoye Rose.—A seedling of the Victor Rose, running back to the original Early Rose for its parentage. The tubers average larger than the Early Rose, and are more oblong in shape. Eyes, broad, open, rather deep set, shading from pink to deep red color; skin, pale pink and finely netted. The flesh is white, firm and dry. Owing to its being as early as the Early Rose, and of better shape, it is bound to be a valuable new variety.

Inability.—Tubers of medium size; oblong and irregular in shape; eyes, deep, open, few in number; skin, white, smooth, specked with small light dots; flesh, white, a little spongy.

Irish Cobbler.—A new early variety, for which great claims are made. In shape it resembles the Early Ohio. The skin is of a creamy white tint, slightly netted; eyes, strong, well developed, but slightly depressed; flesh, white, firm, and when cooked very floury. It ripens about the same time as the Ohio, but is much more productive.

King of the Roses.—One of the new, oblong, Rose varieties of considerable promise. The tubers are regular in shape, of medium size, with a clear pink skin. Eyes, broad; nearly closed, and of average depth. The firm, dry, fine textured flesh makes it a desirable table sort, and it seems destined to be a valuable addition in the Rose growing localities.

Lakeside Champion.—This seems to be a potato that will gain prominence among the late market varieties. It is a strong grower; vines of an upright, vigorous habit; size of tubers large, with very few small ones. Their shape is long, oblong, flattened; eyes are few in number, deep, partly closed, and pink to red in color; skin, white, shaded with pink, smooth, finely netted; flesh, firm, fine grained and white.

Livingston Banner.—But very few of the new sorts gave a larger yield than this, and, considering its good points, it will be, without doubt, a good market variety. The tubers are large, flat ovate in shape, very regular; eyes are few in number, slightly indented; skin, light russet, finely netted; flesh is very firm, cream white, and fine in texture. Appears to be a good keeper.

Maggie Murphy.—The large size and productiveness of this variety is gaining for it a widespread reputation. The tubers are of the Rose color, light pink, and very attractive. The top is very strong and vigorous in its growth; said to be especially adapted to sandy soil. Considering its size, the grain is good, and the flesh very white and dry.

Michigan Beauty. Tubers small; oval, oblong; eyes shallow, partly closed; skin white and smooth; flesh white, firm and of good texture. Not very promising, but will be given further trial.

Napoleon. A medium late variety, with the essentials required for a standard potato. Tubers are large, flat, ovate and very regular; eyes open and shallow; skin pure white; flesh very white, but it is a little spongy and showed some indications of rot in the hills.

Peachblow Seedling. A recent seedling of the Old Peachblow and nearly identical with Fottler's Peachblow. Not very promising.

Pride of the South. One of the earliest new varieties, but aside from its earliness it is not of any special value, as it is lacking in productiveness. Tubers are small to medium, oval shaped, with few very shallow open eyes. The skin is pure white; flesh firm, white and dry.

Rose No. 9. Another of the Rose varieties that promises to be of much value. Tubers are large, well formed, attractive and of good quality.

Rose Standish. Tubers medium to large, oblong flattened; eyes shallow; skin very pink, thin; flesh fine grained, white and dry. Not of especial value.

Stump the World. A very attractive, snow-white potato of medium size, but it is lacking in productiveness. The quality is good and it will be given further trial.

Table King. One of the most promising new varieties, although not very productive. In size it averages about the same as the Ohio, and is very similar in shape. The skin is a light russet color, with few shallow eyes; flesh very firm, white and dry, with a fine texture. It has few superiors in quality.

Uncle Sam. An attractive white potato that will be given further trial. A strong grower; good size; regular shape, but a little coarse and watery.

Harvest Queen. None of the new late varieties are more desirable. The tubers are large, round-oblong, slightly flattened; eyes few and shallow; skin white with a fine netted russet coating which usually marks a potato of superior qualities. The flesh is very dry, white and of fine texture. A strong grower and of average productiveness.

Vigorosa. One of the new varieties that possess merit sufficient to warrant further trial. An early white potato of medium size, cylindrical in shape, with few deep, open eyes. Skin smooth, white, with light pink markings; flesh very white, but a little inclined to be spongy.

Wise's Seedling. A remarkably strong growing variety; stalks large and vigorous, with an upright habit. Size of the tubers, large and a little inclined to be rough; shape, long to oblong, rather irregular; color, white tinted with pink; eyes, darker in color, shallow and few in number; flesh very firm, dry and white and appears to be a good cooker at any season of the year.

$\frac{241}{3}$. Although tested under rather unfavorable circumstances, this new early variety was quite productive and it seems likely to become one of the leaders. The tubers are large, smooth and very white, with slight pink markings; eyes large, strong, partly closed, rather numerous. The flesh is very solid, creamy white and of superior texture. Will be given further trial.

WHERE SHALL WE OBTAIN OUR SEED?

It is claimed by some seedsmen that to insure the largest crop of potatoes the seed should be northern grown, while others claim that tubers

grown on muck land are stronger and will produce more vigorous plants and a larger yield of tubers.

As a test along this line, several varieties grown in Northern Minnesota were secured and compared with potatoes grown in Southern Michigan on muck land, and others of the same varieties grown here on a sandy loam.

The site selected was a part of the early plot, located in the northwest portion of the vegetable garden. Two rows, two hundred and forty feet long, were taken for each variety, and twelve pounds of seed was used per row, the system of planting and culture being the same as with the other varieties.

Early Norther, from Minnesota, showed a gain of ten per cent over seed grown on muck land, while Acme gave an increase of thirty-two bushels per acre over the southern seed.

Early Michigan and Rural New Yorker No. 2, grown on muck land, made about the same showing over the seed grown here in a sandy loam, but it was undoubtedly due, at least in part, to the fact that the other seed was stored in pits while ours was kept in a common cellar, and had become somewhat shriveled before it was planted.

The Colorado beetles were very troublesome this season, which necessitated several applications of Paris green; while the plants were small it was applied with a powder gun, but after they were half grown, land plaster was used in the proportion of one hundred pounds to one of the poison. Water was also used at the rate of one hundred gallons to one-half pound of Paris green.

The entire crop of potatoes was treated with Bordeaux mixture to prevent the working of the early leaf blight, with satisfactory results.

RADISHES.

Seed of the forcing varieties was planted in the hot bed early in March to determine their value for the purpose named.

The forcing sorts, with but few exceptions, are of much the same type. All are of small size and quick maturity. The form differs from round turnip to olive shaped or half-long tapering; the color from white or yellow to all shades of red, scarlet and crimson. The flesh of some varieties is more crisp and tender than that of others, and remains longer in that condition. The time required to produce salable roots, and the size to which they will grow before becoming pithy, are of importance in selecting kinds to grow for this purpose.

Carmine Turnip, Non Plus Ultra, Round Deep Scarlet, Scarlet Globe, Startle and *Twenty Days Forcing* are quite similar in form, but differ in color, size, quickness of growth and crispiness of flesh. Of these *Startle* was the first to mature. It is of a bright, scarlet color, and the flesh is crisp and tender. *Non Plus Ultra* is a little later than *Startle,* but has whiter flesh, and is better in quality. Its season, however, is short, and it must be pulled at once.

Carmine Turnip, Round Deep Scarlet and *Twenty Days Forcing* matured at the same season, and are much alike in general appearance. *Twenty Days Forcing* is considerably larger in size than the others. *Scarlet Globe* was the last of the group to reach its growth, but the slight difference in time of maturity was more than made up in the increase of

size, it being nearly twice as large as any other, and the flesh was crisp and tender.

Deep Scarlet Olive Shaped and *Rose Olive Shaped* differ from the group above described in having roots oval in form, and longer. They are as early, and in bunching will pack more closely than the turnip rooted radishes.

French Breakfast produces roots that are two inches or more long, obovate in form, bright red in color, with lower part white. It is quick maturing, attractive in appearance, and good in quality. Quite generally grown as a forcing sort.

Golden Globe and *White Olive Shaped* are not largely grown because of their color.

Long Brightest Scarlet. This sort is almost as quick growing as the smaller sorts, is as attractive in appearance and as good in quality, while the largely increased size is a point of great superiority.

All the varieties of radish were sown in the open ground May 12. The following table gives the date of maturity of the several sorts grown.

Variety.	Seedsman.	Date of edible maturity.	
Carmine Turnip	Vaughan	June	5
Deep Scarlet Olive Shaped	Ferry	"	5
French Breakfast	"	"	5
Golden Globe	"	"	7
Gray Summer Turnip Rooted	"	"	16
Half-long Black Winter	"	July	8
Long Black Summer	"	"	7
Long Brighest Scarlet White Tipped	"	June	6
Long White Naples	"	"	21
Non Plus Ultra	"	"	4
Rose China Winter	"	July	9
Rose Olive Shaped	"	June	5
Round Deep Scarlet	"	"	6
Scarlet Globe	"	"	6
Scarlet Turnip Rooted	"	"	5
Startle	Johnson & Stokes	"	2
Stuttgart White Giant	Ferry	July	6
Twenty Days Forcing	Vaughan	June	5
White Chartier	Henderson	"	15
White China Winter	Ferry	July	11
White Olive Shaped	"	June	6
White Strasburg	"	"	20
White Summer Turnip	"	"	16
White Turnip Rooted	"	"	6
White Vienna	"	"	20
Yellow Summer Turnip	"	"	15
Siberia	Oregon Ag. Col.	"	29
Mongolia No. 1	" " "	"	28
Mongolia No. 2	" " "	"	21
Japan No. 1	" " "	July	6
Japan No. 2	" " "	"	16
Japan No. 3	" " "	"	16

Unless the soil where radishes are grown is sandy and rich, the roots grow too slowly and become tough and wormy. For this reason some of the smaller growing sorts described among the forcing varieties would give better satisfaction to plant in the home garden. The seed can be sown every week or ten days and a good succession of table radishes obtained throughout the season.

Of the larger-growing radishes, *Long Scarlet Short Top*, *Charlier* or *Rose China* among the reds, and *White Naples* or *White Vienna* of the whites are recommended for general growing. If a medium-sized yellow skinned sort is desired, *Yellow Summer Turnip* is good.

Winter radishes are but little grown, no doubt because their good qualities are not generally known. While their flavor is quite sharp, they will keep through the winter and are most excellent as a relish. Usually the white sorts are the better keepers. The seed should be sown quite late, say the last of August, so that the growth may not become tough and pithy.

SQUASH.

The difficulty experienced in getting the young squash plants well established and beyond the attacks of the striped beetle has deterred many from planting this vegetable. When the number of hills is limited, perhaps nothing would be found more satisfactory than box frames made about one foot square and the tops covered with wire screen or mosquito netting. Place these frames over the hills before the plants come up and leave them there until the growth fills the boxes. When the boxes are removed the plants are usually so far along that they will withstand the attacks of the beetle. Wood ashes, with which a few drops of turpentine have been mixed, dusted on the plants, we have found effective in driving the beetles away. The squash bug begins to attack the plants when they are of some size. This is a very difficult pest to combat successfully. Squash plants are very tender and insecticides that would kill the bugs would also kill the plants. If boards are placed on the ground close to the vines, most of the bugs will crawl under them for protection during the night. Early in the morning the boards may be turned over and the pests killed.

VARIETIES.

Of the early sorts *Crookneck* and *Bush Scallop* are generally grown. While the quality of the early sorts is not equal to that of the winter varieties, yet, because of being ready for use long before the later kinds, they should have a place in every garden.

Straightneck, Vaughan, as grown here the past season, promises an improvement in increased size, with less of the curve that marks the *Crookneck*.

There is a class of squashes with flesh of good quality that mature in the fall and are good winter keepers. *Delicata*, *Perfect Gem*, *Fordhook* and *Cocoanut* are among the better sorts of this class and, as the plants can be depended upon to bear a large crop, they should be much more largely planted for home use than they now are.

With most squash growers *Hubbard* is the variety grown for winter use. *Marblehead* is a sort having a grayish-white skin with a nearly smooth surface, and while somewhat smaller in size than Hubbard, has less waste in preparing for use. The plants are as productive, the flesh as dry and as thick as the Hubbard, and even better in quality. It ripens a little earlier than Hubbard and should be largely grown as a late keeping sort. *Pike's Peak* is also an excellent winter squash.

SWEET CORN.

The test of varieties in sweet corn included thirty-two kinds, consisting of the leading standard sorts and many of the new ones sent out by different seedsmen. The corn was planted June eighth, in rows forty-two inches apart, with five kernels in each hill. The temperature and moisture were such that the seed germinated very quickly and a large per cent grew.

Adams' Extra Early, from Landreth, was the first variety to reach maturity; although it is not strictly a sweet corn, yet for family use, or early market, it does very well. The ears are six to eight inches in length, well tipped and filled with twelve rows of plump, broad, tender, juicy kernels.

Bonanza. One of Vaughan's medium varieties, has a very small cob. The kernels are long, broad, pure white, tender and rich in sugar properties. Its edible maturity is of long duration, making it a valuable sort.

California, from Childs, is very similar to Stowell's Evergreen, but does not have merit enough to take its place.

Champion is a new variety, sent out by Vaughan, that is promising as an early sort. The ears are large and long, well covered with twelve rows of snow white, plump, sweet kernels, set on a small cob. The hull of the kernels is very thin.

Chicago Market, from Vaughan, is one of the old commercial varieties; it is very prolific and of fair quality.

Concord, from Vaughan, is another standard variety with market gardeners and it needs no description to gain friends. One of the best medium season varieties.

Country Gentleman, from Maule, is an established variety that needs no praise, as the small cob, irregularly covered with long, plump, cream white, sweet kernels distinguishes it from other varieties. Its uneven time of maturing makes it valuable for the home garden. A common name for it is *Shoe Peg*, on account of the shape of the kernels, and their not being in rows.

Cory, White Cob, Vaughan. This was the first strictly sweet corn that reached maturity. It differs from the old Cory variety only in the color of its cob; size, shape, texture and flavor are the same.

Dawn, Johnson & Stokes. A variety larger than Cory, maturing four days later; ears well filled; kernels, cream white, large, deep, sugary and very juicy; rows, twelve to sixteen in number.

Egyptian, from Henderson, is a strong, coarse grower; ears very large, white and well covered; kernels, broad, plump, deep and of a peculiar rich flavor. It is a good variety for gardeners or for canning purposes.

Fordhook, one of Burpee's specialties, matured about the same time as Dawn. The ears are about the same size as those of Cory, and they differ but little except in the oval shape of the kernels.

Fottlers, sent out by Vaughan, is a few days later than Cory, and suckers badly. The ears are seven to nine inches in length and are well covered with corn rich in sugar.

First of All, from both Maule and Burpee, is one or two days earlier than White Cory, but there is little difference between them.

Gold Coin, from Vaughan, in growth and development is very much like Stowell's Evergreen, but is not equal to it in quality. The ears are large and well filled with yellow kernels.

SWEET CORN.—TABLE OF VARIETIES.

No.	Variety.	Seedsman.	Ears per square rod.	No. of days from planting to edible maturity.	Height of stalks. Feet.	Average No. of ears per stalk.	Average length of ears. Inches.	No. of rows of kernels per ear.	Length of kernels. Inches.	Diameter of cob. Inches.	Weight of ears. Ounces.
1	Adams' Extra Early	Landreth	210	53	6	1.15	6.5	12	.43	1	8
2	Bonanza	Maule	218	71	8	1.12	8.5	18	.5	1	10.6
3	California	Childs	122	81	9	.8	9	14	.43	1.25	11.2
4	Champion	Vaughan	207	58	6	1.15	7.75	12	.41	1.12	9
5	Chicago Market	Vaughan	186	56	6	1.15	7.25	18	.42	.87	7.6
6	Concord	Vaughan	146	65	7.5	.8	8	14	.46	1.25	9.4
7	Country Gentleman	Vaughan	105	80	8	1	8	20	.5	1	7.4
8	Cory (white cob)	Vaughan	207	54	5	1.15	6	8	.38	.87	5.5
9	Dawn	Johnson & Stokes	194	58	7	1.12	7.75	14	.35	1	8.7
10	Egyptian	Henderson	151	92	9.5	.8	9	12	.37	1.2	10.8
11	Fordhook	Burpee	225	58	5	1.15	7	8	.43	.75	5.8
12	Fottler	Vaughan	223	60	5.5	1.14	7.5	12	.33	1	7.1
13	First of All	Burpee	204	54	5	1.1	6.75	10	.35	.87	6.6
14	First of All	Maule	194	54	5	1.1	7	10	.35	.87	6.4
15	Gold Coin	Vaughan	111	87	9	1	9.5	16	.56	1.12	10.3
16	Hickox Hybrid	Ferry	146	72	9	7	9.5	12	.43	1	11.1
17	Honey Dew	Childs	223	56	5	1.15	7	8	.31	.87	6.9
18	Improved Ruby	Burpee	105	81	8.75	1.25	8.5	14	.43	1.33	11.3
19	La Crosse	Salzer	237	58	6	1.2	7	10	.36	1	8
20	Landreth's Market	Landreth	155	58	6	.75	8	8	.37	1	7.8
21	Landreth's Sugar	Landreth	294	67	8.5	.6	8.5	14	.5	1.18	11
22	Leets	Ferry	214	65	7	1.1	8	12	.35	1	7.8
23	Mammoth	Henderson	220	98	10	1.14	12	16	.62	1.35	14
24	Minnesota	Ferry	239	63	7.5	1.22	7.5	8	.33	.87	6.7
25	New England	Ferry	158	56	7	.75	8	10	.38	.9	8.6
26	Nonesuch	Johnson & Stokes	190	78	8	1	8.5	12	.44	1	9.1
27	Northern Pedigree	Salzer	95	56	5	.5	6	8	.44	1	7.1
28	Quincy Market	Gregory	125	68	7.5	.6	7	12	.44	.87	7.1
29	Roslyn Hybrid	Henderson	105	66	9	.5	8.75	14	.44	1.18	8.4
30	Stowell's Evergreen	Vaughan	110	90	9.75	.55	11	16	.62	1.25	16
31	Sugar, Early	Vaughan	198	57	6.75	1	7.5	12	.33	1	8
32	Vermont Extra Early	Vaughan	180	55	6.75	1.2	7.5	10	.33	1	7.75

Hickox Hybrid, Maule, is one of the best varieties for canning or drying; it is very prolific and shrinks but little in the can or in drying. The ears are large; cob small; kernels very white, sugary and well filled with milk.

Honey Dew, introduced by Childs, is an early eight-rowed variety with small ears covered with long thick husks. The kernels are plump and tender, but it is not as desirable as some other sorts.

Improved Ruby, Burpee. Its only peculiarities are the dark red stalks and husks; ears are large, well filled with pure white kernels of delicious flavor. A fair, medium late variety.

La Crosse, Salzer. A hardy and productive sort maturing well developed ears, medium length, with ten rows of broad, plump kernels; not of extra quality.

Landreth Market, Landreth. The leading feature of this corn is the length of the ears, averaging eight inches, and they are well filled with eight rows of round, plump, good sized kernels. It is not a true sugar corn, but is of the same nature as Early Adams.

Landreth Sugar, from Landreth, is a very promising variety. The ears are large, growing very low on the stalks; grain very narrow, long, white and sugary, remaining milky for a long period, which makes it desirable for canning or continuous marketing.

Leets, obtained from D. M. Ferry & Co., is about a week later than Cory. The ears are larger than those of the earlier sorts; cob small; kernels long and rich in sugar. It lasts well and is a good medium early variety, but it is not equal to Country Gentleman and some of the other varieties in flavor.

Mammoth, Henderson, grew the largest ears of any variety, and matured about three days later than Stowell's Evergreen, making it a valuable late sort. The ears are covered with long, broad, plump, milky, tender kernels that are rich in sugar.

Minnesota, from Ferry, is a variety maturing between Cory and Concord. It is better in quality than the former, and the ears are larger. The leading characteristic is the dense covering of the ears with long thick husks, and the broad flat form of the kernels.

New England, another variety from Ferry, grows a very long, slim ear, well covered with broad, tender, sweet kernels, but it is less desirable than Minnesota and other varieties. Much shriveled when dry.

Nonesuch, from Johnson and Stokes, is one of the medium varieties; a strong grower; ears of good size, with pink cobs, but with very white kernels that are tender and sweet. The leaves, stalks and the cob end of the kernels are tinged with pink.

Northern Pedigree, from Salzer, is a very dwarf-stalked variety, with small, plump ears, covered with deliciously sweet kernels; sweeter than Cory but not as productive.

Quincy Market, sent out by Gregory, is almost identical with Crosby, except that it is a few days earlier. The quality is about the same, but the flavor, if anything, is a little better. An excellent variety to follow Cory.

Roslyn Hybrid, from Henderson. This variety is a valuable medium late sort, remaining in edible maturity a long time. Its growth is much like Stowells' Evergreen. The ears are large, long, well filled and covered with broad, deep kernels of fine quality, tender and milky.

Stowell's Evergreen, Vaughan, is a standard variety, and by many considered to be the best sugar corn grown. The ears are very large and

long; kernels broad, deep, of cream white color, tender and very sweet. Its length of edible maturity is one strong point in its favor.

Sugar, Early, is one of Vaughan's introductions for this year, and appears to be nearly identical with First of All and Vermont Extra Early.

Vermont Extra Early, Vaughan. It grows strong stalks which average one good ear. The ears are a little larger and longer than those of Cory, but they have a larger cob. The kernels are of good length, well rounded, plump, juicy, and as sweet as any of the earlier sorts. It is preferable to Red Cory.

TOMATOES.

The seed was sown in the forcing house March 19. When ready the young plants were removed to boxes and set in the open ground May 27 and 28. The rows were five feet apart and the distance between the plants in the row was four feet. The plants grew very luxuriantly and bore large crops of fruit. The tomatoes were remarkably free from rot and no spraying was required.

In the table below will be found the date of first fruit ripening; the productiveness of each sort, compared in percentage, taking varieties producing the largest crop at 100 per cent; the part of the whole crop ripe September 15, at which time a frost may usually be expected, and the average weight of a single ripe fruit of each variety computed by weighing a large number of tomatoes and averaging their weight. By taking the per cent of productiveness with the part of the crop ripe September 15, and the average weight of a fruit, a fair comparison of the several varieties may be made. (C) in the table of seedsmen indicates that the variety has been grown here at least one year and that the seed is of our own saving.

TOMATOES.

Variety.	Seedsman.	Date of first ripening.	Productiveness. Per cent.	Per cent of crop ripe Sept. 15.	Average weight of a single ripe fruit. Ounces.
Acme	Vaughan (c)	Aug. 15	92	55	7.4
Advance	College	" 11	83	85	4.4
Alexander	Delano Moore	" 3	90	90	5.6
Atlantic	Buckbee (c)	" 12	85	90	6.3
B. B.	Johns'n & Stokes (c)	" 15	85	10	8.0
Beauty	Vaughan (c)	" 15	70	30	8.8
Brandywine	College	" 15	78	20	6.8
Bright & Early	Dreer	" 8	80	45	3.0
Chemin	Thorburn (c)	" 15	75	50	10.0
Conqueror	Thorburn (c)	" 15	85	70	5.2
Crimson Cushion	Henderson (c)	Sept. 4	72	20	13.8
Cross No. 1	Va. Agrl. Col. (c)	Aug. 26	90	40	7.0
Cross No. 2	Va. Agrl. Col. (c)	" 19	84	45	9.4
Cross No. 3	Va. Agrl. Col. (c)	" 19	95	85	8.3
Daybreak	Dreer	" 23	70	25	7.2
Democrat	Thorburn (c)	" 15	90	55	8.2
Dwarf Aristocrat	Buckbee (c)	" 13	96	90	7.6
Dwarf Champion	Vaughan (c)	" 15	65	25	6.4
Favorite	Vaughan (c)	" 15	78	50	9.8
Ferris Wheel	College	Sept. 1	88	20	12.0

TOMATOES.—CONCLUDED.

Variety.	Seedsman.	Date of first ripening.	Productiveness. Per cent.	Per cent of crop ripe Sept. 15.	Average weight of a single ripe fruit. Ounces.
Fordhook	Vaughan (c)	Aug. 18	78	10	6.8
Fortune	Johnson & Stokes	" 27	98	20	8.4
Golden Jubilee	Childs	" 15	88	50	10.2
Golden Queen	Vaughan (c)	" 15	92	70	8.6
Hybrid No. 1	Landreth (c)	" 10	95	55	5.6
Hybrid No. 4	Landreth (c)	" 15	60	55	6.8
Hybrid No. 22	Landreth (c)	Sept. 4	86	20	2.6
Hybrid No. 25	Landreth (c)	Aug. 16	96	20	3.0
Hybrid No. 50	Landreth (c)	" 15	75	35	5.0
Imperial	Maule (c)	" 8	98	50	9.2
Jersey	Landreth (c)	" 15	98	70	6.8
Large Red	College	" 15	88	50	6.5
La Crosse	College	" 15	85	35	7.0
Leader	Vick	" 15	90	75	6.4
Lemon Blush	Thorburn (c)	" 20	65	35	8.2
Liberty Bell	Vaughan (c)	" 23	80	20	6.5
Long Keeper	Vaughan (c)	" 15	70	60	6.0
Miner	A. A. Miner	" 19	100	50	18.2
Minnesota	Dreer	" 8	85	85	4.0
Mixed Red and Purple Cross	Landreth	" 17	88	60	5.4
McCollum's Hybrid	College	" 16	95	85	8.4
Money Maker	Landreth (c)	" 15	100	50	5.4
New Stone	Vaughan (c)	" 8	98	25	10.4
Northern Light	College	" 27	98	25	8.5
Novelty No. 22	Landreth	Aug. 8	99	42	5.4
Novelty No. 24	Landreth	" 15	100	20	1.4
Optimus	College	Sept. 1	92	65	9.6
Perfection	Vaughan (c)	Aug. 15	78	70	8.0
Potato-leaf Ignotum	College	" 27	100	65	12.6
Ponderosa	Henderson (c)	Sept. 4	90	20	11.2
Purple Cross	Landreth	Aug. 15	99	85	5.6
Purple Olive Cross	Landreth	" 20	95	25	4.9
Puritan	Thorburn (c)	" 16	98	50	7.4
Red Cross	Landreth	" 20	96	25	9.2
Ruby	Henderson (c)	" 8	98	80	6.8
Ruby Queen	Childs	Sept. 4	90	5	14.0
Scarlet Cross	Landreth	Aug. 15	95	85	7.4
Seedling	W. Va. Station (c)	Sept. 10	72	5	16.6
Shah	College	Aug. 20	96	65	8.7
Ten Ton	Landreth (c)	" 15	82	55	6.8
Terra Cotta	Thorburn (c)	Aug. 19	98	50	6.4
Thorburn	Thorburn	" 8	88	20	7.8
Three Celled Cross	Landreth	Sept. 10	94	5	4.8
Tomato No. 105	Johnson & Stokes	Aug. 8	98	40	8.6
Tom Thumb	College	" 8	88	60	4.0
Tree Tomato	Buckbee (c)	" 15	85	15	4.8
Turner Hybrid	Vaughan (c)	" 27	92	45	12.0
Upright Station	Thorburn (c)	Sept. 1	25	15	4.3
Virginia Corker	Landreth	" 7	74	25	8.
Volunteer	Vaughan (c)	Aug. 15	65	85	10.4
Buckeye State	Vaughan (c)	" 27	98	85	9.8

NOTES ON VARIETIES.

The following are sorts but recently introduced:

Alexander, Delano Moore, Presque Isle, Maine. Plants similar in mode of growth to Advance, but the leaflets are larger and have not the grayish tinge. Fruit varies from round flattened to ovate flattened, or often quite irregular; size, small to medium; colors very evenly a bright,

deep red; flesh, a deep red of fine grain and good quality. Of the Earliest type, but more even in size and regular in form. Valuable for extreme earliness, good color, form and quality. Does not crack or rot and is a very productive sort.

Bright and Early, Henry A. Dreer, Philadelphia. Plant and plant growth closely like Advance, though perhaps slightly more erect in habit. Fruit exactly similar to Advance in form but will not average as large in size; the color of the skin is more of a golden yellow, due to the larger size and more numerous yellow dots on the surface. A few fruits were ripe before those on Advance, but the general crop was later and the plants were less productive.

Daybreak, Dreer. Plants are not of strong growth, rather upright in habit; foliage of Acme type, but the leaf stalk is larger, and marked by having numerous small, pointed leaflets between larger ones. Fruit closely of Ignotum type but the cell walls are thicker and the angles more prominent. Not as productive as most sorts.

Fortune, Johnson & Stokes, Philadelphia. Plants of an upright habit of growth, but so vigorous that they spread over a large amount of space. Foliage of Acme type, but the leaflets are larger and more deeply cut. Fruit closely resembles Ignotum in form and color, but has thicker flesh walls and the skin is tougher. It is also later in ripening.

Golden Jubilee, John Lewis Childs, Floral Park, N. Y. Plant growth low down, straggling; leaflets large and coarse. The fruits are large, round or ovate, often somewhat angular; flesh walls thick; cells small and numerous; color a bright yellow often with green streaks running from base to apex, considerable green around base. Fruits are a deeper yellow and flesh much more solid than Golden Queen. The plants are productive and all the fruits are large, but are often scabby at apex and cracked around base.

Leader, James Vick's Sons, Rochester, N. Y. Plant of low, straggling growth; foliage, light green; leaflets, small, close set, partly curled. Fruits of fair size, quite irregular and angular. While the first ripening was not so early as some others, the bulk of crop was ripe at an early date. Quite closely of Earliest type of fruit, though scarcely so early, and tomatoes are more angular, too much so to sell well in market.

Miner, A. A. Miner, Luther, Mich. Plants of largest growth; foliage of Potato Leaf type. Fruit closely resembles Turner Hybrid, though scarcely so thick and the apex is more depressed. One of the most productive sorts in the field, and the fruits will average larger in size than Ponderosa though scarcely so regular. Flesh solid and of good quality. An excellent tomato.

Minnesota, Dreer. Plants of low, straggling growth; foliage of Ignotum type, but the leaflets are smaller and slightly curled. Fruits closely resemble those of Dwarf Champion, though the cell walls are more prominent, making small angles. Flesh bright red and of good quality. The variety is very productive and one of the best early ripening sorts, bearing small to medium sized fruits.

Novelty No. 22, D. Landreth & Sons, Philadelphia. Plants of strongest growth; foliage closely like that of Acme, though the leaflets are farther apart and the texture more papery. Fruit medium in size, spherical in general outline, deep from base to apex, the color varies from purplish red to bright red with golden dots; flesh of good color and quality. The plants are very productive, and while many fruits are small the large crop

borne gives a fair yield of good fruits. We hope by selection to improve the variety.

Novelty No. 24, Landreth. The fruits are of Plum type and too small in size to be of commercial importance.

Thorburn, J. M. Thorburn & Co., New York city. Plants are of strongest growth and lie close to the ground; the foliage is of Acme type but with fewer leaflets and are farther apart on leaf stalk. Fruits are of good size, varying in form from round to ovate; color light purplish red with yellowish streaks; flesh dark color, solid and of good quality. A distinct sort. Type not fixed.

Tomato No. 105, Johnson & Stokes. Plants of very vigorous growth; foliage of Acme type, but the leaflets are a lighter green and vary greatly in size, and fruits vary much in form and size, but their general outline is of the Ignotum type; the color varies from a light, bright red to Acme color; flesh of excellent quality. Type not fixed. Nearly all the fruits produced are of good, marketable size. Seed has been selected to improve and fix the red type.

Virginia Corker. Landreth. Plants of largest growth; foliage of Acme type, but the leaf stalks are longer and leaflets larger and farther apart. Fruit of Ignotum form and color, though scarcely so regular in general outline. The bulk of crop was late in ripening.

Landreth's Cross-Breds. Several varieties of tomatoes were sent out by D. Landreth & Sons, of Philadelphia, under the name of Cross-Breds. While the type of many of these is not fixed, there are several sorts that have much promise. Careful selections were made of the best fruits of the better kinds, and an effort will be made to fix and improve them.

Of the sorts grown for one or more seasons, the following are worthy of special attention:

Dwarf Aristocrat is a sort resembling Dwarf Champion in plant growth, but the fruits are larger in size, and of a bright red color. The plants are more productive than Dwarf Champion, and ripened a much larger proportion of the crop. Like Dwarf Champion, it ripens a few fruits quite early and the bulk considerably later, yet, from the larger size of the fruits and the greater plant productiveness, it is to be preferred to that well-known variety.

Potato-leaf Ignotum. Several years ago a plant was noticed in the Ignotum patch having foliage resembling Turner Hybrid, while the fruit was similar to that on neighboring plants of Ignotum. Seed was saved from fruits of this plant, and by careful selection a new variety has been secured. The fruits are quite like Ignotum in form, but they are larger in size, and the flesh is a trifle coarser and more solid at center. The plants are very productive and ripen the greater part of the crop quite early in the season. A very desirable sort.

Terra Cotta. This variety is unique in form and in color of skin, and in the deep, rich color of flesh, and has been greatly improved in size of fruits by careful selection of seeds. It is an excellent sort for home use, but, on account of the thin skin and tender flesh, will not carry well to market.

Ignotum. For several seasons this variety has been the one grown for the general crop. The fruits are large, of good form and quality. The plants are productive, and ripen a good proportion of the crop before frost comes. The following sorts are closely of Ignotum type of fruit, though

differing slightly in color and form, in appearance of plant and time of ripening:

B. B., Brandywine, Favorite, Liberty Bell, McCollum, New Stone, Optimus, Perfection, Ten Ton and Volunteer.

Acme. This is one of the best sort for market, where purple tomatoes are desired. The plants are productive and ripen the purplish red fruits quite early in the season.

Beauty, Imperial, Long Keeper and Buckeye State are quite similar to Acme, though slight differences, mark the varieties.

Ponderosa. This sort, though late in ripening, bears very large fruits, having a flesh somewhat coarse in texture but of good quality. If one desires a variety bearing large, solid tomatoes that are good keepers, Ponderosa would give satisfaction. Ferris Wheel and Crimson Cushion are much like Ponderosa.

SUMMARY OF VARIETIES.

Vaughan's Earliest is one of the best early ripening sorts, though the new selection, Alexander, has shown up remarkably well and may crowd it for first place.

Advance is a little later than Earliest, but the fruits are smooth and more regular in form.

Ruby and *Atlantic Prize* are recommended as early ripening sorts having fruits of good marketable size.

Acme, *Beauty*, *Ignotum*, *Perfection*, *Potato-leaf* and *Optimus* are named as excellent sorts for the general crop.

Miner and *Ponderosa* bear very large solid fruits, but the time of ripening is rather late.

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FERTILIZER ANALYSES

By R. C. KEDZIE, Chemist of the Experiment Station

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E. A. A. GRANGE, V. S., Consulting Veterinarian.	C. E. MARSHALL, Ph. B., Assistant Bacteriologist.

SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.

FERTILIZER BULLETIN.

COMMERCIAL FERTILIZERS A MODERN PRODUCT.

Concentrated manures as commercial articles are very modern and were unknown fifty years ago. Their starting point was the suggestion of Liebig, that bones could be made more active by treating them with sulphuric acid. This was in 1840; J. B. Lawes of Rothamsted, Eng., took advantage of the hint by using the acid to convert mineral phosphates into soluble or superphosphates, about 1850, and the manufacture of superphosphates and other artificial manures on the commercial scale was soon established and grew to vast proportions, laying the foundation for the large fortune which has enabled Sir J. B. Lawes to endow the Experimental Farm of Lawes & Gilbert at Rothamsted. Thus commercial fertilizers laid the foundation of the greatest experiment station in the world.

One reason why superphosphates came so speedily into favor with British farmers was the special beneficial influence in the growth of the turnip crop—the special manurial crop in British agriculture. They found that superphosphates greatly promoted the growth of the turnip in its earliest growth, carrying the plant beyond its critical stage before the true leaves are formed at which time it is liable to be destroyed by the turnip fly. In the English system of rotation of crops, the turnip is the manurial crop, on which the other crops in the rotation depend, occupying in British agriculture about the same position that red clover does with us. Hence the early favor and great popularity of these concentrated manures in England.

In this country the introduction of concentrated manures has been slower for two reasons: 1, we have no such specialized crop as the turnip which becomes the pivot of the whole rotation and for which a concentrated manure is almost indispensable; 2, The virgin soils of our

When the modern scientific dairy methods are compared with the methods of ten and twenty years ago, the significance of bacteriology becomes apparent. Answers to the questions of the causes of various abnormal conditions have been given. The souring of milk and its putrefaction, the appearance of color, the presence of a bitter taste, and ropiness have all been explained. Cream is now ripened by pure cultures, cheese is made in accordance with the laws of fungal and bacterial growths, and the commercial requirements demand Pasteurized milk.

MILK AS A FOOD FOR BACTERIA.

The chemical composition of milk appears to the bacteriologist not by the number of components involved but rather by the value each component possesses as a food for bacteria. Considering the analysis of milk in this light and remembering what was said in Bulletin 139, p. 68, regarding the food requirements of bacteria, the component parts of milk may be resolved into three classes: the nitrogen class, the carbohydrate or sugar class, and the fat class. The inorganic salts are essential but subsidiary to our purpose.

The first class is represented by casein, the parent substance of cheese. It is this which provides the bacteria with the necessary nitrogen for their development. Owing to the various actions bacteria have upon casein, it affords us a means of ascertaining how different species attack its molecule and thus aids us in determining species. In some cases there is a process instituted similar to putrefaction and again there is simply a digestion of the casein. With other species there is no change whatever in the casein. Whatever change is undergone by the action of bacteria, it furnishes them with nitrogenous food. Sugar of milk (lactose) is the main component of the second class. Containing carbon, hydrogen, and oxygen, it offers three food elements to bacteria. The atoms of carbon, hydrogen, and oxygen making up a molecule of sugar are sometimes torn asunder; lactic acid which usually produces the souring and curdling of milk, alcohol which is utilized in the manufacture of certain alcoholic milk drinks, and carbon dioxide gas are the resulting fragments of the destroyed molecule of sugar.

In the third case but one element has been mentioned, the fat. Upon this substance bacteria have little effect, except indirectly. The bacteria do not seem to feed upon it or change it in any manner. The changes that appear to take place in cream and butter are usually traceable to other compounds than fat. So seldom is fat acted upon by bacteria that it is almost disregarded by bacteriologists.

In milk, nitrogenous food is in abundance, carbon, hydrogen, oxygen, and inorganic salts are not lacking, consequently milk is an excellent food for bacteria.

MILK IN THE UDDER.

Milk in its *normal* condition in the udder is free from all forms of bacteria. This is an old belief that has been established repeatedly by numerous investigators in Europe and elsewhere. Some have ventured

to question this accepted belief; yet, from the present standpoint, bacteriologists in general adhere to the old work.

There are, however, two methods by which milk may be contaminated even in the secure gland, the udder: the one, when a cow is affected with some bacterial disease; the other when bacteria find their way through the milk duct of the teat into the milk sac at the base of the teat and thus into the ducts which lead into the sac from the glandular substance of the udder.

In the discussion of the first method we are urged to consider tuberculosis, by its importance and the interest centered upon it at present. In this dreaded disease, which causes the death of every eighth person, the *bacillus* of tuberculosis may find its way into the milk if present in the cow. This is more likely to take place if the disease is located in the udder. In this case, tubercles formed by some process of irritation of the *bacillus*, multiply in the tissue making the udder. At first they are generally little hard nodules; but these keep enlarging and eventually become soft, caseous and even purulent; a semi-fluid pus is found in them. If one of these tubercles should be located along any one of the numerous milk ducts leading to the milk sac, and it should grow, finally breaking down into a purulent substance, the contents of this tubercle with the thousands of *tubercle bacilli* it contained would rush down the milk duct into the milk sac and would thus contaminate the milk. We have supposed that the disease was seated in the udder; is it possible if the disease is confined to the lungs or other organs? We are permitted to answer only in the affirmative, inasmuch as the *bacilli* have been found present in the milk when no local lesions of tuberculosis could be discovered in the udder. Just how they, the bacilli, reach the udder involves too many suppositions and complications to even suggest in this place. When it is ascertained how they make their journey from a tuberculous lung to the milk gland, it will be time to discuss it, and it will then be simple to understand. That the *bacilli* of tuberculosis may reach the milk in the udder of a cow no matter where the disease is located in that cow is indisputable, having been established by competent workers. The per cent of tuberculous cows giving tuberculous milk varies from a very low figure to a very high or startling figure, consequently, the *milk of tuberculous animals is dangerous.*

The other method of contaminating the milk in the udder is through the milk duct of the teat. Although apparently closed to all foreign substances, it nevertheless fosters hosts of bacteria. For some time past, bacteriologists have been reporting the number of bacteria found in the "fore" milk, "middle" milk and strippings. Invariably they find the most to abound in the "fore" milk. The first milk drawn from a cow washes out the ducts and leaves few bacteria to infect the "middle" milk and strippings. In another way the duct may be demonstrated to be burdened with bacteria. Disinfect the udder and teats with as much care as possible, introduce a sterile milk tube connected with a sterile flask closed with cotton wool into the milk duct, and the milk after standing in these flasks for some time will show the presence of bacteria. Out of twenty-eight samples obtained in this way the author obtained only two which were sterile. In a very few of these samples, several weeks were required to show any change whatever.

On the other hand, where the precaution was observed to remove some milk before the insertion of the milk-tube, a larger portion of the samples was sterile. In working with contagious mammitis, the author has obtained pure cultures of Nocard's streptococcus by following the method above. This method is described in Bulletin 140, page 101.

CONTAMINATION OF MILK AFTER LEAVING THE UDDER.

It is not my intention to give practical methods to be observed in the perfection of cleanliness about the cow, barn, and dairy. My province is confined to the habits of bacteria and their relation to milk. To avoid their access to milk, I shall simply offer general suggestions. Some of these may seem anticipatory and impracticable, still we live in an age of progress and changes, and hope to see feasible methods realized some day. It must not be expected that the dairyman and bacteriologist will accord in these matters; both will, however, work in unison to a satisfactory solution of the problems in hand.

As soon as the milk has escaped the duct of the teat, the chances of contamination have multiplied greatly. The avenues of access have increased and may be considered under: exposure to the air of barn and dairy; exposure to the filth from the cow; exposure to the particles of dirt from the milker; exposure to the milking and dairy utensils.

Exposure to Air of Barn and Dairy.—The number of bacteria varies with the locality and circumstances. The air over a meadow is comparatively free from bacteria; in the city air the number has multiplied a thousandfold, and if we pass on to the air of a cow stable, the number has increased several thousand fold over that of the city. Unless each individual is willing to make an experiment for himself, he will appreciate in a small degree the contaminating power of the cow stable air. This knowledge may be gained in a crude way by exposing a smooth surface, as glass, to the air of a stable for a few minutes, and while the exposure is being made watch the small, almost imperceptible particles of dust falling upon it. Each particle represents by no means a single microbe, but scores of them which adhere to the surface. As each particle becomes dissolved in milk those germs which are hidden within its interior are liberated for activity.

Currents of air serve to facilitate the travel of these micro-organisms. Bits of decomposing matter, pieces of straw from the manure heap, and the pulverized dirt and dung of the stable and barnyard are picked up and borne along, and part of them will find their way into the milk.

Any disturbance of dust must be avoided. The handling of hay at the time of milking or before only adds many fold to the germ content of the air. The stirring of the bedding is obnoxious. The hay and straw are loaded down with bacteria awaiting only a suitable food in which to grow.

In a well kept dairy the air bacteria are not numerous. The dairy I now have in mind has a cement floor and a good drain; with these two agencies it is possible to keep down the dust. Where there is a board floor, unless it is kept exceptionally clean, there is always a stream of dust, visible or invisible, rising when passing over it. In such instances

there must be many bacteria in the air which eventually fall into the milk.

Exposure to the Filth from the Cow.—There is nothing more filthy than the filth from the cow. There is nothing that is so effectual in rendering milk unwholesome. There is no part of the handling of milk that needs revolutionizing and renovating more than the process of milking. After studying this feature for an extended time the student loses his hunger for milk. We accept the conditions as they are simply because we are accustomed to them and they have come to us as an inheritance.

The American method of milking is simple. The milker sits down to the cow, with the milk pail on his knee exposed to much of the filth he brushes from the udder, teats, and lower portion of the cow with one sweeping motion over the entire region. Upon these parts of the cow will be found lumps of dung, pieces of straw, loose hairs, epidermis scales and dirt from various sources. If a clean glass plate is exposed underneath the cow, the amount of filth that will collect is surprising. In this filth can be discerned particles of straw, dung, dirt, loose hair and epidermis scales. The bacteriologist is unable to make a correct estimation of the number of bacteria contained, although numerous estimations have been made. Conditions vary and it is impossible to bring every bacterium in contact with the food medium in which only a part will grow. Again there may be no complete dissolution of the particles loaded interiorly with bacteria, for milk drinkers very frequently meet with undissolved particles of dirt at the bottom of their glasses. Millions have been counted and probably many more millions fall into the milk during the process of milking.

Exposure to Particles of Dirt from the Milker.—A milker may add much to milk contamination by means of dirty hands and clothes. Although we cannot say that this source furnishes as much filth as the two preceding, yet there is a possibility of danger from this source which the other two sources are not likely to possess. This danger is that which arises from the contagion of contagious or infectious diseases. A milker may carry upon his clothes the bacilli of diphtheria, of typhoid fever and other obnoxious diseases. A tuberculous subject should never milk when the milk is to be consumed by others. In some unseen way the baccilli of tuberculosis find their way into the milk and thus menace the health of those who drink the milk. It is thought that scarlet fever has been communicated through milk probably by means of the milker. Some of the most contagious diseases have failed of recognition because we have not yet identified the micro-organisms concerned, and therefore are unable to trace them definitely.

Exposure to the Milking and Dairy Utensils.—This means of contamination is under the absolute control of the dairymen, for it lies within his power to rid his utensils of all bacteria. However, it is not usually the case that the milk-pail is bacteria-free. How frequently it happens that a dairy utensil after it has been cleaned according to the common methods has a greasy film over its surface which may be easily detected with the finger. The crevices are filled with dirt which may be scraped off with the point of a pen-knife. Upon studying the dirt adherent to the milk-pail, it has been discovered that it is almost a mass of bacteria. This was found after the pails were treated with brush and steam but not with sufficient care. A *little* brushing, a *little* hot

water, and a *little* steam are *little* effective; what is needed is hard brushing until all the dirt is removed, and the addition of plenty of *hot* water (212° F.) for several minutes, and if steam, let it run for a few minutes. This is necessary if the life in the pail is destroyed. Too much care cannot be exercised in this direction.

Since milk in the udder is free from bacteria and the only likely contaminations are through the sources named above, the importance of cleanliness is manifest.

VARIETIES OF BACTERIA IN MILK.

It would be unsafe to place any definite limit to the number of species found in milk since it harbors bacteria which may come from almost any source. The conclusion is forced that the number of species is unlimited.

Those bacteria which find their home in the filth of the barnyard, the dust of the barn or dairy, in the soil and water, are the species usually found in milk. To consider the possibilities of their actions is beyond our present scope. Suffice it to say that the bacteria usually finding a residence in milk belong to the saprophytic and non-pathogenic class.

There is a class of bacteria which having once established themselves in a dairy, become a part of it and exert their influence daily. These are the lactic acid bacteria, and they are constant factors in the ordinary milk changes.

MULTIPLICATION OF BACTERIA.

The bacteria having gained access to the milk and finding a suitable temperature soon begin to multiply. How rapidly they may increase has been considered in Bulletin 139, p. 67. If we start with several millions and increase in a geometrical ratio using every thirty minutes as the unit of time, the enormity of the number after a few hours growth is scarcely imaginable. Frequently after the milk has stood several hours it is possible to find hundreds of thousands in a single drop. Too rapid souring of the milk is not desirable, and if obnoxious bacteria grow in this way and gain the ascendency over the lactic acid bacteria, bad and even harmful results are obtained.

To secure the best milk products, it should be the plan of every dairyman to delay unnecessary fermentation by whatever legitimate method is at his command. Perhaps the most economical and inexpensive is the cold water method of reducing the temperature below that required for the growth of bacteria.

INFLUENCE OF TEMPERATURE UPON BACTERIA IN THE DAIRY.

Cold prevents growth, heat checks growth or kills the bacteria. Out of fifteen lactic acid producing bacteria, isolated by Kayser (Cent. f. Bact. II. Bd. I. p. 436) none formed lactic acid at 10° C., even when allowed to act for thirty-five days. Five would not produce curdling at 15° C. This shows that a low temperature is able to keep milk from souring for a long period. It must not, however, be understood that cold kills the bacteria or renders them inactive when they are transferred to a warm temper-

ature. On the other hand, it simply retards their growth while they are under the influence of the cold only, for when they are transferred to a warm temperature they grow as readily as those bacteria which have been kept at a warm temperature for some time.

When we take milk from the cow and put it immediately into a cooling vat, we simply keep the bacteria from multiplying. They remain dormant, as it were, as long as the milk remains cold. But if the milk is placed in a warm atmosphere, they will multiply as rapidly as though they had never been chilled. To be successful, therefore, in handling milk in the cold, it is necessary to cool it as soon as possible after milking and to keep it cool until consumed.

The heating of bacteria either checks their growth or kills them. There is a great difference among the various species in regard to this. While some are killed at 60° C., others seem to be uninfluenced and still others merely have their growth checked. This is true at the different temperatures ranging from 60° C. to 100° C. There is quite a number of bacteria which will withstand a heating of 96° C. for twenty minutes and will continue to grow as though they had not been subjected to any enervating influence. The large class of lactic acid bacteria is mostly destroyed at a temperature of 65° C. but there are a great many, usually those containing spores, remaining that will cause various actions upon milk. As a rule, they first curdle the milk, then peptonize it.

It is not possible to heat milk indefinitely, without altering it chemically, therefore destroying its palatability. In heating milk above 75° C. there is always produced a cooked taste. Consequently we are limited in the application of heat as a means to exterminate bacteria.

PASTEURIZATION AND STERILIZATION.

This is simply the application of heat as the means to exterminate some or all of the bacteria present in milk. Pasteurization consists in heating the milk at 70° C. for twenty minutes (the temperature and time are both variable). Pasteurization has been resorted to in order to obviate the cooked taste in milk, to enhance its keeping qualities, to kill disease-producing germs and to reduce the number of ordinary milk bacteria. Its intrinsic value lies mainly in its destruction of disease-producing germs. Concerning a further discussion of this matter, I take pleasure in referring you to Bulletin 133, and the bulletin that follows.

Complete sterilization is impracticable in the commercial handling of milk. It produces a cooked taste in the milk rendering it unpalatable. It changes the composition of milk, to a certain extent. There is no demand for it. There are, however, purposes for which sterilization is absolutely necessary, but for a commercial product, little can be said in its favor. It is true that in sterilizing milk, we kill all the bacteria present, yet this is no argument, inasmuch as ordinary milk bacteria produce no direful effects in the animal economy.

MILK FERMENTATIONS.

Through fermentations in milk, bacteria manifest their presence. It would make no especial difference how many bacteria entered the milk

if they simply developed, and consumed a portion of the milk, produced no diseased conditions nor altered the composition of the milk. But when we consider that all of the usual changes in milk are due to the actions of these bacteria, their rôle at once begins to assume an important part in dairy economy.

Our acquaintance with the usual fermentations about us, such as the changing of cider into vinegar, grape juice into wine, and the like, helps us to conceive of milk fermentations. In order that we may arrive at a systematic understanding of this question, it will be necessary to divide the subject into several heads:

Bacteria producing pigment;
" " alcohol;
" " lactic acid;
" " butyric acid;
" " rennet ferment;
" " slimy milk;
" " bitter milk;
" " soapy milk;
" " poisonous milk.

Although some of these functions cannot with propriety be assigned to fermentation, still these bacterial functions can with profit be considered coördinately.

PIGMENT FORMATION.

There is reason why this is not more commonly observed. Inasmuch as many bacteria which produce pigment will not grow and give rise to pigment in an acid medium, any pigment-bearing bacteria are likely to be passed over unnoticed; still anyone familiar with the bacteria of milk will tell you that a failure to isolate pigment from any ordinary sample of milk is a rare occurrence. They are common in milk and either do not succeed in developing along with the many other species present or the acidity destroys the pigment. Although this is usually the case, there are many plagues of colored milk occurring in dairies.

A common color in milk is red. This may be due to a variety of bacteria. A yeast plant has also been found by the author in many samples of milk originating from the same source. The color produced by these pigment producing micro-organisms may be simply a scum over the surface or may be uniformly distributed throughout the milk.

There are many yellow pigment bacteria found in milk. All shades will be noticed, from an orange yellow to a lemon yellow. These bacteria may find their way into the milk from the air, dairy or cow, since they are widely distributed. Most of the yellow pigmented bacteria produce a peptonizing ferment which is not advantageous to the quality of cream or milk.

A greenish color is also quite frequently present. It usually originates from flourescing bacteria which have fallen in generally from the cow. In their action upon milk they produce a very unpleasant odor which seems to be characteristic of this class.

Perhaps the most common pigmented disease of milk is what the Germans call " blau milch." It is uniquely common in the northern part of

Germany and in certain districts of Europe, but in this country the cases are not so common. This trouble is due to a bacillus which grows very rapidly in milk. With the formation of acid or the regular souring of milk it gives a sky blue color; but if the milk remains sweet, it yields a slaty appearance. The source of this bacillus is probably the filth which contaminates the milk; yet its sudden appearance at times would lead to other deductions. The germ is harmless in itself and yields no strongly poisonous products. It has also been found in cheese and in such a case yielding blue cheese. The most certain way of eradicating it is by careful disinfection and cleaning.

ALCOHOLIC FERMENTATION.

It is a common characteristic of many bacteria as well as yeasts to produce alcohol. This substance is widely distributed in various fermentations either as a resulting primary product, as in beer and wine fermentations, or as a secondary product, in reality a by-product, in intestinal fermentation. Many of the bacteria permanently resident in the intestines will yield sufficient alcohol—during their process of development in certain food preparations—to give a decided chemical reaction. The alcohol usually is the result of the destruction of some carbohydrate—that is sugars, starches and like substances.

Milk sugar (lactose) may be converted into alcohol under favorable conditions. The presence of the proper ferment is only required in connection with a suitable temperature to change milk sugar into alcohol. Although this fermentation has little practical significance for the dairyman, there are sections in which the alcoholic fermentation of milk is of considerable value, inasmuch as the alcoholic milk is used as a drink by the inhabitants.

Koumys, milk wine or lac fermentatum, originally prepared from mares' milk, but now from cows' milk as well, to which some sugar has been added, has been used for hundreds of years in Asia and the name is taken from the tribe which first employed it. Many sanitarians recommend it because they regard it as more easily digested than the milk as it comes from the udder. While alcohol is the chief product of fermentation, it must not be forgotten that lactic acid and acetic acid enter into its composition. In wine fermentation there are several minor products as fusel-oil, acetic acid, glycerin and others, so here we have analogous secondary or by-products, and these by-products lend flavor to the taste.

Kephir is a preparation made by the people of Caucasus and is made from the milk cows and sometimes of other animals. There seems to be present in kephir fermentation three distinct fermentative agents: the lactic acid ferment which produces a certain amount of lactic acid equal usually to that of the alcohol; the yeast or alcoholic ferment which makes the preparation an alcoholic drink; [Hammersten is made to say by Fleischmann that out of 100,000 parts of kephir 727 parts are lactic acid and 720 parts are alcohol,] and the peptonizing ferment which renders some of the casein soluble. Although the lactic acid and alcohol come from the milk sugar, a good portion of the latter is left.

The preparation is effected through the instrumentality of kephir-grains which are yellow, hard, and about the size of a pea. These grains

are apparently zoöglea of bacteria and yeast plants [See Zoöglea Bul. 139.] used as we employ yeast.

LACTIC ACID FERMENTATION.

This is the fermentation with which we have so commonly to deal; it is the ordinary souring of milk. Before the days of bacteriology, it was supposed to be due to a chemical change instituted by the oxygen of the air; it was also recognized that the nitrogenous components of the milk had an important bearing in the development of lactic acid in the milk. Pasteur in his biological explanations of fermentation was able to demonstrate that lactic acid fermentation or the ordinary souring of milk was due to micro-organisms. Lister was the first to isolate a single species which had this special function. Hueppe has given us several species which are well known as Hueppe's lactic acid bacteria. Many lactic acid micro-organisms have been described since Hueppe's, all having certain characteristics in common but differing in some morphological or cultural features.

Each dairy has its lactic acid bacteria and it would be found that while belonging to the lactic acid group of micro-organisms, they would represent perhaps several species. These lactic acid bacteria become the property of every dairy; once located they grow and increase with the dairy, inhabiting every cranny, dairy utensil and barn; the entire milking outfit is their home and they are fed at each milking and at the same time multiply rapidly.

The souring of milk is the conversion of milk sugar into lactic acid by the action of micro-organisms. In this change small quantities of carbonic acid gas and alcohol are likely to be evolved also; however these are lost sight of in the formation of the acid. The casein of the milk is cast down by the acid formed and thus gives the curdled appearance of soured milk. After a small per cent of acid is formed, the lactic acid bacteria cease to grow; hence it is that the acidity never reaches a very large per cent, from .5 to .8 per cent.

The temperature at which this fermentation takes place lies between 18⅓° C. [65° F.] and 35° C. [95° F.] but is perhaps conducted best between 23° C. [75° F.] and 30° C. [85° F.]. The bacteria which produce the fermentation grow very slowly below 15° C. [60° F.] and are readily killed at 68° C. [155° F.]. Bearing in mind the relation of temperature to the growth of the lactic acid bacteria, the regulation of this fermentation may be carried out at will. The questions: "Why does milk sour more quickly in hot weather?" or "Why does it sour so suddenly before a thunderstorm?" find their answers in the consideration of temperature.

In the process of Pasteurization, the lactic acid bacteria are usually killed; accordingly, those bacteria which remain in the milk after Pasteurization are those bacteria which precipitate the casein or curdle the milk not by the formation of any acid but by the secretion of a ferment; consequently, curdled Pasteurized milk has little acidity.

A lactic acid fermentation product which has been used by the Armenians as a drink and the ferment of which they have employed in the making of butter is called "matzoon." Its taste is that of a rich butter-

milk and its appearance resembles a very fine granular and frothy curd. It is manufactured in this country by Dr. Dadirrian of New York, and is highly recommended by professional people. The analysis given and compared with kumyss is as follows:

	Matzoon.	Kumyss.
* Water	87.69	90.99
Proteids	3.98	2.04
Fat	4.01	1.91
Milk sugar	2.03	3.26
Alcohol	.07	0.62
Ash or mineral salts	.78	.44
Carbon dioxide	.04	.44
Lactic acid	.50	.00
Acetic acid	.00	.30

Matzoon is certainly very palatable and I understand that it is used almost exclusively in Armenia. The milk as it comes from the cows is scarcely ever used, but in place of it matzoon is commonly employed.

In its prepartion, the milk is Pasteurized at a high temperature and some matzoon is added to it as a ferment. The milk is then placed away until fermentation takes place. The longer it stands the sourer it becomes. It is therefore used when fresh or is kept in a cold place to allay fermentation.

Dr. Dadirrian, of New York, and Mr. Caramanian, of this College, have kindly furnished me with samples of matzoon and the desired information.

BUTYRIC ACID FERMENTATION.

The importance of butyric acid fermentation is not so great to the dairyman as the one preceding (lactic acid fermentation), but it has its significance in the various changes which occur in milk, butter, and cheese. Its presence may be detected by the rancid butter odor. Usually in milk treated by the ordinary methods, this fermentation seldom obtains a perceptible start. In butter exposed to favored conditions for decomposition assisted by certain micro-organisms, it is of very common occurrence, and is recognized by the butter's rancidity. A distinct butyric acid fermentation is often noticed in cheese.

As in lactic acid fermentation so in butyric acid fermentation, Pasteur was the first to demonstrate its relation to micro-organisms. It was he who was first able to combine certain chemical compounds in a solution and by the introduction of an almost pure culture of a single species of bacteria establish the fact that a certain component of this solution, a lactate, a form of lactic acid, was changed into a butyrate, a form of butyric acid. Although Pasteur did not work with an absolutely pure culture of a single species of bacteria, his culture was nevertheless sufficiently pure to prove the action of this single species. In this connection, it is interesting to note that the micro-organisms with which he was dealing, was one that would not grow in the presence of the free oxygen of the air; in short, it was an anaërobic bacillus, the first that was ever considered. It is also interesting to note that many of the anaërobic bacteria are in some way associated with the formation of

* Prof. Wm. H. Porter, M. D., Merck's Bulletin, Vol. VI., Nos. 1 and 2.

butyric acid. Besides Pasteur, Conn, Fitz, Prazmowsky, Hueppe and others have added much to the study of butyric acid fermentation.

Attention has already been called to its presence in milk, butter and cheese, but its presence elsewhere in nature must not be overlooked. In the intestinal tract there is a certain amount of butyric acid produced by the action of bacteria and in some cases in such large amounts as to render the functions of the lining membrane abnormal and thus produce one form of dyspepsia. Again it is found in some of our food fermentations, as sauerkraut.

This fermentation may result from the transformation of grape-sugar, starch, lactic acid and albuminous substances. In milk, it is generally considered to be the change of lactic acid and by others to sometimes occur directly from milk sugar. As by-products, carbon dioxide and free hydrogen are eliminated. Inasmuch as this fermentation takes place in the presence of the nitrogenous constituents of the milk, such as casein, there are other products manufactured by a secondary fermentation of these micro-organisms which tend to neutralize any acidity present and dissolve or throw in solution the casein. This secondary fermentation may belong to the butyric acid micro-organisms or may be the result of the activity of other micro-organisms. However this may be, ammonia and ammonia compounds and derivatives of ammonia are frequently found present.

PEPTONIZING FERMENTATION.

Intimately associated with the rennet ferment is the peptonizing property of some bacteria. These bacteria are usually those that have the power to produce the precipitation of casein, but the peptonizing action follows that of the rennet action; yet this is not always true, for there are those bacteria which are able to peptonize without the production of any rennet ferment, although they are comparatively few in number. It would seem that these bacteria acted somewhat differently in the peptonization of casein, because there are those cases where we have the solution so perfect or the casein so completely peptonized that the milk has become as clear as water; there are those, also, which are able to peptonize the casein only in part, so that the casein remaining settles to the bottom, usually in a gelatinous mass with a watery layer above; and again there are those which peptonize the casein only in part and leave it in a semi-clear condition.

The change of the casein is similar to the change of meat in the process of digestion. Our meat is changed into a soluble form before it is assimilated by the organs of assimilation. In the case of casein by the action of this peptonizing ferment, a soluble product is obtained which is closely allied to the soluble product obtained from meat by the process of digestion. This product from meat is known as peptone and from casein as caseon.

RENNET FERMENTATION.

Imagine a series of vessels of equal size all having the same amount of milk in them, before you, and in each a single species which possesses the rennet action. You would be able to discern that there is a great variety

of appearances in the precipitated casein. There would be all shades, from the truly loppered milk to the finely granular particles of casein often produced by the action of bacteria. While we are able to affirm that these conditions exist and are able to see them and note the differences, yet we are unable by the use of language, to describe these differences.

A rennet action consists in the precipitation of casein and may occur under acid or alkaline conditions of milk. In the formation of lactic acid the casein is precipitated by the direct action of the acid upon the casein; but when we have a neutral or alkaline solution, the action is different, it is the result of a ferment produced by bacteria. This ferment is capable of separation; it, when isolated, may be introduced into milk and produce the precipitation of the casein.

In a large number of species of bacteria obtained from Pasteurized milk, it is markedly noticeable that most of them will precipitate the casein of milk without the formation of any acid.

BITTER MILK.

It is not an unusual occurrence upon tasting a bowl of milk to find that it is bitter. This bitterness is due to bacteria which gain access to the milk and then give rise to products of a bitter taste. Hueppe was of the opinion that this bitterness was due to the formation of peptones by the peptonizing bacteria and we are not at all certain that this action is not in certain cases accompanied by bitterness, although in many cases it seems the result of special products.

Dairies and factories have been visited by these bitter milk bacteria with great loss. Weigmann has also demonstrated their presence in cheese. Wherever they are found in milk or its products the total destruction of the material usually follows.

ROPY OR SLIMY MILK.

The subject of ropy milk has been discussed in Bulletin 140, in which was described a bacillus that was found to produce ropy cream. It will not be out of place, however, to mention in this connection a few of the most important features of ropy milk and cream. The number of bacteria producing this condition of milk and cream is exceedingly large and if more attention were given to the morphological and cultural study of these bacteria, this number could probably be reduced considerably, because it would probably be found that several of these now distinct species would be proved identical. The one cited in Bulletin 140 has many characteristics common with several of the species concerned in the production of ropy milk; yet owing to the scarcity of detailed data, it was impossible to identify it at the time of writing the bulletin. We will not stop, however, to consider the various bacteria as species associated with this condition of milk and cream, but will only state that they vary greatly in their methods.

One species will produce ropy milk through the adherence of one bacterium to another by means of an adhesive cell wall, and this ropiness will not only manifest itself in milk but also in other media in which

it may be grown. Another species will produce ropy or stringy milk by changing the milk sugar into a viscous form and again we will have other species acting upon the albuminous substances, it may be the casein of the milk, changing them into a slimy mass.

If we should isolate several species which are commonly present in milk and allow them to grow for a long period in milk, unassociated with any other species, we would find after several weeks that there would be some producing a condition of the milk which would be slimy and even ropy in many cases. From this we would conclude that ordinarily there are found in milk, bacteria which would give rise to either ropy or slimy milk, provided all the conditions were favorable to their development.

It is fortunate, however, that there are desirable germs which gain the ascendency over these undesirable germs, therefore they are usually unable to manifest their presence. Whenever we find species which grow more rapidly than the lactic acid bacteria, we are then made aware of their presence by their actions upon the milk and only then do we meet with ropy or slimy milk.

SOAPY MILK.

A peculiar condition of milk is that of soapiness. Upon handling it, it responds much like soft soap. An instance of this kind was reported by a dairyman in Illinois, who said that if his whey tanks were not scalded, his whey would appear like soft soap upon dipping. Several other occurrences of this nature are recorded in literature, but it is necessary to say only that these circumstances are brought about by specific micro-organisms which have a tendency in their action upon milk to convert it into a soapy condition. In my work in the laboratory, I have found bacteria isolated from milk which would produce the above condition. These bacteria seem to act upon the casein and albumin.

POISONOUS MILK.

We have satisfied ourselves thus far that bacteria are able to act upon milk in diverse ways. Some of their actions we regard as beneficial, while others as sorely detrimental. In the consideration of the production of poisons by bacteria, we must bear constantly in mind that although this phase of bacterial action stands out very prominently and has a peculiar interest, it is simply coördinate with the other manifestations of bacteria in milk. Instead of having lactic acid or butyric acid as the product of bacteria, we have an intense poison, hardly comparable with poisons known to us. Vaughan, of the University of Michgan, has the credit of being the first to isolate a poison called tyrotoxicon, which is perhaps the most common of bacterial poisons in milk. It was originally found in cheese, from which it took its name, but it has been repeatedly found in milk, ice cream and cheese. In "Ptomains and Leucomains," the authors, Vaughan and Novy, have cited several cases of milk poisoning. In one case, "on August 7, twenty-four persons, at one of the hotels at Long Branch, were taken ill soon after supper. At another hotel, on the same evening, nineteen persons were seized with

the same form of sickness. From one to four hours elapsed between the meal and the first symptoms." * * * While the cause of the sickness was being sought for, and one week after the first series of cases, thirty persons at another hotel were taken ill with precisely the same symptoms as noticed in the first outbreak. " * * * Further inquiry revealed the fact that all who had been taken ill had used milk in greater or less quantities, and that persons who had not partaken of milk escaped entirely; corroborative of this, it was ascertained that those who had used milk to the exclusion of all other food were violently ill. This was prominently noticed in the cases of infants fed from the bottle, when nothing but uncooked milk was used. In one case an adult drank about a quart of the milk, and was almost immediately seized with violent vomiting, followed by diarrhœa, and this by collapse. Suffice it to say, that we were able to eliminate all other articles of food and to decide that the milk was the sole cause of the outbreak."

"Having been able to determine this, the next step was to discover why that article should, in these cases, cause so serious a form of sickness."

"* * * * * * It was soon ascertained that one dealer had supplied all the milk used at the three hotels where the cases of sickness had occurred. His name and address having been obtained, the next step in the investigation was to inspect all the farms, and the cattle thereon, from which the milk was taken. We also learned that two deliveries at the hotels were made daily, one in the morning and one in the evening; that the milk supplied at night was the sole cause of the sickness, and that the milk from but one of the farms was at fault."

"The cows on this farm were found to be in good health, and, besides being at pasture, were well fed with bran, middlings and corn-meal."

"* * * * * * * The cows were milked at the unusual and abnormal hours of midnight and noon, and the noon's milking—that which alone was followed by illness—was placed, while hot, in the cans, and then, without any attempt at cooling, carted eight miles during the warmest part of the day in a very hot month. * * * * * *"

"The results of our inquiry having revealed so much, we next attempted to isolate some substance from the poisonous milk, in order that the proof might be more evident."

"* * * * * * We are justified in assuming, after weighing well all the facts ascertained [*I have purposely omitted the chemical examination. Author*] in the investigation, that the sickness at Long Branch was caused by poisonous milk, and that the toxic material was tyrotoxicon."

Associated with these cases of poisonous milk, we invariably find undesirable methods or circumstances for the handling of milk. Either filth has furnished these toxicogenic bacteria or they have got in from what might be called natural sources and have developed under conditions to which no milk should be subjected.

BACTERIA IN BUTTERMAKING.

Sweet cream makes an insipid butter, unmarketable and undesirable. We have always been accustomed to butter made from soured cream, and unless we have an evolution in taste, butter made from soured cream will always be in demand. We know from our discussions so far that there is always a possibility of having bacteria present which will induce within the cream abnormal changes. It is therefore a matter of importance to secure if possible only those bacteria which will produce the desired change in the cream. In seeking these bacteria, it should be the aim to select those varieties which will give rise to that peculiar acid flavor coming from soured cream, as well as the nutty flavor arising from the aroma and to yield a butter of good keeping qualities. Having once gained such a species of bacteria, we shall then be able to obtain a uniform product. As to the acid flavor in butter, there is some question. Dr. Conn makes the claim that acid-producing bacteria are not essential in the production of rich flavored butter. His experience with bacteria in the ripening of cream commands consideration, but there are those who positively affirm that acid-producing bacteria are absolutely essential to a highly flavored butter. Inference would lead us to suppose that one's taste is accustomed to the acid flavor, and of course, would demand it. On the other hand, there is no doubt that the non-acid variety of bacteria will give delicate shades of tastes which would be very pleasing to a connoisseur. It cannot be expected, however, that the laity will cultivate their tastes to these delicate shades. When we bear in mind that the keeping quality of butter is a very necessary property, we are led to believe that the acid-producing bacteria are the more desirable. Out of thirty or forty bacteria isolated from milk, it will be noticed that those which form acid stop their growth when the acid has reached such an amount as to inhibit their growth. The acid formed is usually sufficient to inhibit the growth of other bacteria for a considerable length of time, barring out certain species. The non-acid producing bacteria generally at first curdle the milk, then continue their action by peptonizing the casein giving rise many times to disagreeable products. If this latter class of bacteria should be used in ripening cream, we should expect a continuous change in products from the very beginning of the ripening process to the final decomposition products of butter, hence the keeping qualities would be lowered.

Therefore to obtain a good flavored butter, a good keeping butter and a uniform product, it is necessary to resort to "starters," of the proper kind established only by experimentation.

There are several kinds of starters in use: a sour milk starter, a buttermilk starter, a ripened cream starter and a pure culture starter.

The sour milk starter has been used commonly by dairymen of late and it has furnished satisfactory results in those cases where it has been impossible to obtain pure cultures of bacteria. Close attention, however, must be given to the appearance of the soured milk. It is conceded that a truly loppered milk is best for this purpose, for it represents the typical action of the lactic acid bacteria. It is obtained usually by allowing the cream to rise by the gravity system and after the cream is removed, the skim-milk is utilized as a starter. This starter may be

applied to cream obtained from the separator or it may be applied to milk which is set aside according to the gravity system. By the use of such a starter, the cream or milk is inoculated with bacteria desired in the ripening of the cream. These bacteria by being in large quantities gain the ascendency over the other bacteria present in the milk or cream and thus produce their specific action.

The use of buttermilk as a starter, in the same way as the soured skim-milk, has met with considerable success in the making of butter, yet it seems that there are more chances of obtaining poor butter in the use of buttermilk than in the use of the soured skim-milk. This is owing to the fact that the buttermilk is farther removed from the soured milk and is therefore more likely to be contaminated with detrimental bacteria.

In the case of cream, the chances appear still greater, for we are all aware that cream undergoes successive changes more readily than either soured milk or buttermilk.

The pure culture starter is beyond doubt, the most desirable and the most succssful that has been or can be used. Dr. Conn in his B. 41 has given to the dairy world a starter which has yielded excellent results in the quality of the butter. It has been repeatedly tested and has been found to comply with all the properties attributed to it. Dr. Conn has more recently stated that it is a question whether the flavor, the aroma and the keeping qualities can be provided by single species. He has found several lactic acid bacteria which would produce an excellent quality of butter and also several other species which do not belong to the lactic acid class which would produce butter equally as good.

There are several pure culture starters upon the market and most of these belong to the lactic acid class. They usually give satisfactory results, but at times, I fear, owing to commercial enterprises, they are worthless, either from contaminating species or from no growth at all. To furnish a uniform species as a starter in a pure culture requires a very conscientious commercial company.

About the use of the pure culture starters, when once obtained, we may state that they are added to a small quantity of cream which is allowed to ripen, then this cream is added to the gathering for the day. A certain portion of the ripened cream is then used as a starter from day to day, until it is noticed that the action of the pure culture added has been weakened or entirely destroyed. Several modifications of this method could be given but it is unnecessary in this general description.

PASTEURIZATION OF MILK.

CHARLES E. MARSHALL.

It is not our purpose to give a general discussion of this topic, for a bulletin devoted to that theme has already been issued from this station by Prof. C. D. Smith. We shall be limited to certain experimental data which will add to the fund of information gleaned from the general consideration.

Heretofore the study of Pasteurized milk has been confined to the process in its entirety. Our efforts have been along another line, and we have approached the subject from another standpoint, hoping thereby to gain an insight into the hidden changes of the process. Pasteurization is aimed at the bacteria in milk, and we have endeavored to isolate some of the bacteria remaining after Pasteurization for the purpose of studying them in pure cultures and of ascertaining their relation to Pasteurization.

Our work and consideration may be resolved into the following heads:

1. *The isolation of species from Pasteurized milk—those species left in milk after Pasteurization and not yielding to Pasteurizing treatment.*
2. *Determining the source of such bacteria.*
3. *The study of their actions upon milk.*
4. *The investigation of the thermal death-points of the species isolated.*
5. *The effect of sudden cooling after Pasteurization upon the species isolated.*
6. *The restraining influence of cold upon the species isolated.*
7. *The restraining influence of heat upon the species isolated.*
8. *The restraining influence of heat followed by a low temperature upon the species isolated.*
9. *Suggestions as to the reduction of infection.*
10. *The value of Pasteurization.*

METHODS EMPLOYED.

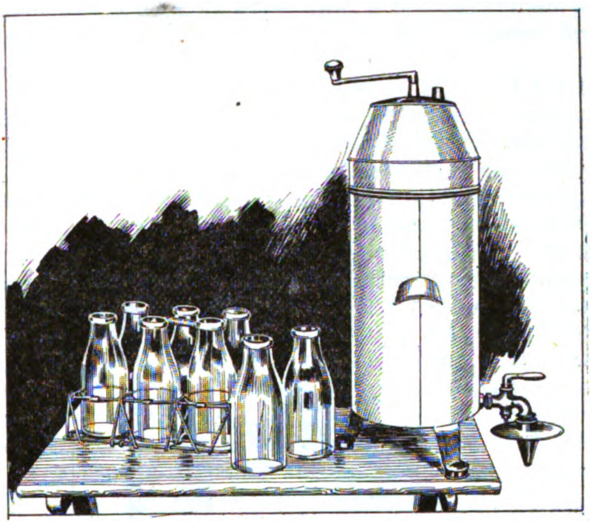
Before discussing the above heads, it may be advantageous to review the methods employed in the process of Pasteurization.

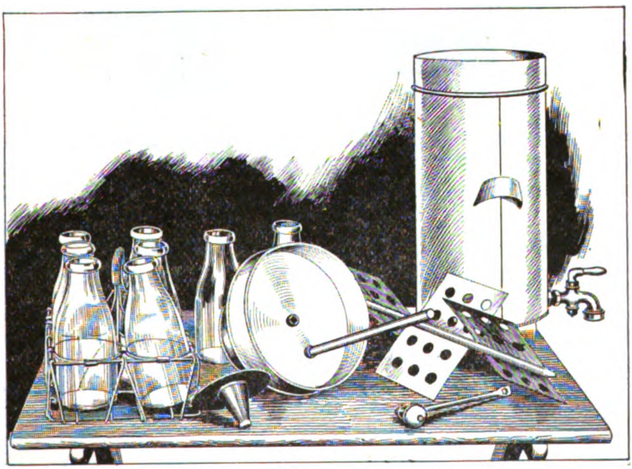
What Constitutes Pasteurization.—Two factors are mainly concerned in Pasteurization, temperature and time. Inasmuch as both are variable, owing to the opinions of different workers, it was necessary to fix upon a definite degree of temperature and period of time. To do this intelligently it is well to bear in mind the principal objects of Pasteurization. Perhaps most vital so far as bacteria are concerned is to have the heating sufficiently high to kill or reduce the virulence of the disease-producing (pathogenic) bacteria. The most important object from the dairyman's view is to keep the milk below a temperature which will produce a cooked flavor or change the composition of the milk. The temperature was placed at 68° C. [155° F.]. The thermal death-points of the pathogenic bacteria which may gain access to the milk probably fall below this, and the change in the composition of the milk and the cooked flavor do not appear in any noticeable degree below 75° C. [167° F.]. The period of time is twenty minutes, a sufficiently long time to attain the objects above.

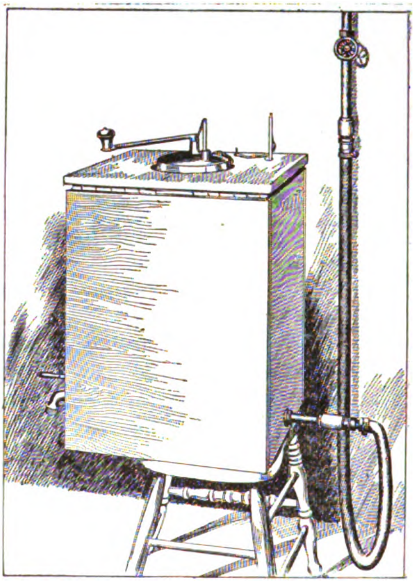
Apparatus Used.—It is a little unfortunate that necessity compelled us to change or modify the apparatus in the midst of our work. Owing to the unsatisfactory results obtained from the first used, we were forced into the modification.

The first used was a shotgun can 8 in. in diameter and 2 ft. deep, with a stirrer inserted through a slit in the cover. The objections to this were, the constant exposure of the stirring rod and its interrupted contact with the milk, the exposure of the thermometer used in determining the temperature of the milk, and the slit in the cover itself, as well as the crude means of getting the milk into the bottles by a siphoning process.

The modification used overcame to a large extent these objections. The truncated conical cover of the shotgun can was made solid with a single perforation which contained a closely-fitting tube, the top of which overlapped a raised portion on the upper side of the cover. The handle was fitted to the upper portion of the cover and to the lower portion of the cover corresponding with the handle above was a cap into which fitted the rod, resting on a pivot in the bottom of the can and carrying the fans used in stirring. The cover overlapped the can by two inches and was made to fit smoothly. So arranged, the cover of the can could be revolved by the handle and in turning the cover, the rod bearing the fans inside revolved. The tube passing through the cover down into the milk was used for the reception of the thermometer in taking the temperature of the milk. Since they all revolved with the cover the tube did not interfere with the fans. In this way, neither the stirrer nor thermometer furnished a source of contamination and there was no opening in the cover to allow bacteria to enter. At the bottom of the can was a brass stop-cock, having a cap screwed over it while Pasteurizing and when ready for drawing off, a mouth-piece screwed on in place of the cap. This mouth-piece was conical in shape that it might fit into the mouth of the bottle and at the base of the cone was a three-inch circular flange to arrest any falling dust.







The can is placed in a galvanized tank lined on the outside with inch matched boards and over which is a wooden cover with a hole in the center for the protrusion of a part of the can cover, and a small hole in the corner for the thermometer.

The bottles used had a neck so fitted that a hot paraffined paste-board circular cover could be pushed down tightly and covered farther with paraffin.

The Process.—The apparatus and bottles were steamed for thirty minutes before using. After the milk had been placed in the can and the can in the tank, the parts were adjusted for conducting the work of heating. The water in the tank was kept equal in heighth with the milk in the can and the steam turned on from time to time as required to keep the water at the proper temperature, which was not allowed to exceed 70° C. [158° F.]. During the heating the milk was stirred constantly. As soon as 68° C. [155° F.] was reached by the milk, the stirring was stopped and the water in the tank was held at 68° C. [155° F.] for twenty minutes. At the expiration of twenty minutes, the can was removed from the heating tank and placed into a cooling tank containing a freezing mixture and the milk was constantly stirred while cooling. When the temperature had fallen to 10° C. [50° F.] or below, the can was removed and the milk drawn off into bottles. In drawing off the milk, the cap was first removed from the faucet and the mouth-piece substituted, care being used in handling the mouth-piece where the milk does not touch it. A little of the milk was drawn off at first before drawing into the bottles to rinse the mouth-piece, although sterilized. When the bottle was nearly filled the milk was turnd off and the hot paraffined cap immediately placed on the mouth of the bottles. In handling the bottles, they were taken from the sterilizer when wanted, in an inverted position only and the mouth was not turned uppermost till it was adjusted to the mouth-piece and underneath the three inch flange.

THE STUDY OF SAMPLES.

After Pasteurization two bottles were brought to the laboratory, and also, with them, two bottles of the same lot of milk, put up with sealed mouths just as the other but un-Pasteurized. These latter were regarded as controls. In the first half of the samples the data is very limited, but in the second half, care was exercised in several details which may not have any direct value in the work, yet these very details will help to check the work; consequently a history of each sample which may be referred to when desired, will be appended.

But before considering the samples by themselves, we wish to say that one sample bottle of the Pasteurized milk of each lot was opened and several plates were made from it; also it was tested for acidity. One of the un-Pasteurized sample bottles was also opened and tested for acidity.

The other sample bottle of each lot of Pasteurized milk and the other of each lot of un-Pasteurized milk were placed away at room-temperature and when changed were tested for acidity, odor, and other qualities, as shall be noted in the history of each.

Sample.	Time of milking.	Time of receipt in laboratory.	Time required in raising to 68°C.	Time of heating at 68°C.	Time required in cooling to 10°C or below.	Time of Pasteurizing the milk.	Change of milk first noticed. Pasteurized.	Change of milk first noticed. Un-Pasteurized.	Condition of Pasteurized milk when changed.	Reaction of Pasteurized milk when changed.	Condition of weather at time of change.	Test for lactic acid.	Per cent of acidity when received, un-Pasteurized.	Per cent of acidity when received, Pasteurized.	Per cent of acidity when changed, un-Pasteurized.	Per cent of acidity when changed, Pasteurized.	Odor of Pasteurized milk when changed.
A	....	Nov. 12	57½ min.	20½ min.	16 min.	....	40 hrs.	....	Loppered.	Acid.	Warm.	....	....	....	....	....	
B	....	" 17	30 "	23 "	28 "	....	48 "	....	"	"	"	....	....	....	....	....	
C	....	" 21	34 "	20 "	20 "	....	48 "	....	"	"	"	....	....	....	....	....	
D	....	" 23	36 "	21 "	23½ "	....	42 "	....	"	"	"	....	....	....	....	....	
E	....	" 24	30 "	20 "	26 "	....	45 "	....	"	"	"	....	....	....	....	....	
F	....	" 25	26 "	23 "	16 "	....	47 "	....	"	"	"	....	....	....	....	....	
G	....	" 27	41 "	21 "	40 "	....	60 "	....	"	"	Cool.	+	....	....	....	.315	
H	....	" 28	47 "	20 "	27 "	....	64 "	....	"	"	Cold.	+	....	....	....	.446	
I	....	Dec. 1	30 "	20 "	23 "	....	62 "	62 hrs.	"	"	Mean 11° F	+	....	....	.441	.126	
J	....	" 2	27 "	21 "	20 "	....	60 "	60 "	"	"	" 13⅓°F	+	....	....	.517	.189	
K	....	" 3	33 "	20 "	18 "	....	103 "	103 "	"	"	" 18⅔°F	+	....	....	.528	.189	
L	....	" 4	41 "	20 "	17 "	....	79 "	79 "	"	"	" 28° F	+	....	....	.491	.339	
M	....	" 5	30 "	20 "	12 "	....	72 "	72 "	"	"	" 33⅓°F	+		....	.561	.441	
N	1 p. m.	3:40 p. m. Jan. 11	19½ "	24½ "	28 "	2:08 p. m.	147 "	116 "	Granular curd.	"	" 24° F	+	.164	.164	.441	.189	Sweetish.
P	"	" " " 12	12 "	20 "	28 "	1:54 "	100 "	96 "	Fine & loose "	"	" 16⅓°F	+	.151	.151	.503	.327	Taffy odor.
O	"	3:30 " " 14	13 "	21 "	28 "	1:55 "	90 "	82 "	" " "	"	" 23⅓°F	+	.176	.176	.476	.406	Sweetish.
Q	"	" " " 15	18 "	22 "	23 "	1:50 "	96 "	72 "	" " "	"	" 27⅓°F	{ + Un-P. / − P. }	.164	.164	.466	.152	Sweet cider.
R	"	" " " 18	17 "	30 "	19½ "	1:57 "	79 "	55 "	" " "	"	" 17° F	+	.176	.176	.441	.378	Taffy odor.
S	"	3:55 " " 19	24 "	20 "	25 "	1:36 "	96 "	73 "	Granular "	"	" 14⅓°F	+	.165	.165	.441	.416	" "
T	"	3:00 " " 26	17 "	20 "	19 "	1:27 "	88 "	64 "	" "	"	" 4⅔°F	+	.189	.189	.579	.492	Sour milk odor.
U	"	3:30 " Feb. 2	23 "	22½ "	16½ "	1:47 "	...	48 "	....	"	" 29° F	+	.189	.189	.477	.414	Sweetish.
V	"	3:45 " " 4	18 "	23 "	16½ "	1:55 "	90 "	48 "	Scarcely marked.	"	" 27⅓°F	+	.189	.189	.402	.389	Sour milk odor.
W	"	3:00 " " 8	28 "	20 "	12 "	1:31 "	72 "	36 "	Loppered.	"	" 29⅓°F	+	.176	.176	.428	.402	" " "
X	"	3:00 " " 10	13 "	25 "	18 "	1:42 "	60 "	48 "	....	"	" 27⅓°F	+	.189	.189	.516	.408	" " "
Y	"	4:00 " " 11	17 "	20 "	45 "	2:38 "	79 "	48 "	"	"	" 23⅓°F	+	.202	.202	.453	.415	" " "
Z	"	3:30 " " 12	11 "	23 "	23 "	1:50 "	74 "	50 "	"	"	" 25° F	{ − P. / + Un-P. }	.189	.189	.529	.157	" " "

It is evident from *Sample I* to *Sample U* that there is no difference in the length of time between the change in the Pasteurized sample and its control, although the measure of acidity differs very markedly in samples I, J and K. From this the conclusion was drawn that the Pasteurizing apparatus used was not sufficiently accurate. There were too many entrances for foreign bacteria by way of the rod, the slit in the cover and the pouring into bottles. This resulted in the author's designing another Pasteurizing apparatus based upon the shotgun can and described elsewhere. The samples from N to Z were prepared in the latter apparatus.

The last half of samples furnished interesting data. The reaction of both the bottle of the Pasteurized milk and that of the un-Pasteurized was taken from the duplicate samples of each immediately upon their receipt in the laboratory. The indicator used was phenol-phthalëin. It will appear from a study of this phase of the work, that although the time after milking was about the same, the acidity varied considerably, and that, as has been stated by several writers, the reaction began to change from the amphoteric directly after milking. This was not the primary purpose of this work, however; we wanted a mark from which to measure the change in the milk, consequently the determination of the reaction at this stage provided us with a starting point.

The bottles were watched closely in the laboratory and as soon as the thickening of the milk was noticed, the time was noted from the hour of receipt. This was thought a fairer test of the keeping qualities than the placing of the bottles in a refrigerator, although the temperature of the latter could be kept more constant. Inasmuch as the keeping qualities are determined in hours, a tabulated statement will perhaps give us a better notion of the comparative values of the Pasteurized and un-Pasteurized milk. The temperature of the room varied from 45° F. to 70° F.

Samples	N	P	O	Q	R	S	T	U	V	W	X	Y	Z
Pasteurized	140	100	90	96	79	96	88	—	90	72	60	79	74
Un-Pasteurized	116	96	82	72	55	72	64	48	48	36	48	48	50

It must be borne in mind that the variability of the change among the different lots is due to the rise and fall of temperature during the work, and that each lot consisting of Pasteurized and un-Pasteurized bottles were treated identically the same and were under exactly the same conditions. Although the relation of temperature differs between the different lots, it does not affect the relation of the bottles of the same lot, consequently the above table offers no direct bearing upon the work when read from right to left, but its significance comes from reading up and down.

When the milk either Pasteurized or un-Pasteurized became the least thickened, the acidity was tested and recorded in each bottle of every lot. Again by this act we gain some idea of the progress of the change as in the number of hours and likewise the kind of change, whether acid or alkaline. At the same time, Uffelmann's test for lactic acid was applied.

The following tables will show the per cent of acidity in the Pasteurized and un-Pasteurized samples at the time when a change was first noted.

Sample ...	N	P	O	Q
Pasteurized	.189 in 140 hrs.	.327 in 100 hrs.	.406 in 90 hrs.	.152 in 96 hrs.
Un-Past'zed	.441 in 116 hrs.	.503 in 96 hrs.	.479 in 82 hrs.	.466 in 72 hrs.

Sample	R	S	T	U
Pasteurized ...	.378 in 79 hrs.	.416 in 96 hrs.	.491 in 88 hrs.	.414
Un-Pasteurized	.441 in 55 hrs.	.441 in 72 hrs.	.579 in 64 hrs.	.477 in 48 hrs.

Sample	V	W	X	Y
Pasteurized ..	.239 in 90 hrs.	.402 in 72 hrs.	.403 in 60 hrs.	.415 in 79 hrs.
Un-Pasteurized	.402 in 48 hrs.	.428 in 36 hrs.	.516 in 48 hrs.	.415 in 48 hrs.

Sample	Z
Pasteurized	.151 in 74 hrs.
Un-Pasteurized	.529 in 50 hrs.

Closely connected to the above is the response to the lactic acid test.

Samples......	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
Lactic acid...	+	+	+	—	+	+	+	+	+	+	+	+	—	Pasteurized milk.
Lactic acid...	+	+	+	+	+	+	+	+	+	+	+	+	+	un-Pasteurized milk.

The following table will show the gain in the per cent of acidity from the time of the test made upon the receipt of the milk in the laboratory to the time when the first change was noticed.

Sample ...	N	P	O	Q
Pasteurized.	.025 in 140 hrs.	.176 in 100 hrs.	.230 in 90 hrs	—.012 in 96 hrs.
Un-Past'zed	.277 in 116 hrs.	.352 in 96 hrs.	.303 in 82 hrs.	.302 in 72 hrs.

Sample	R	S	T	U
Pasteurized . .	.202 in 79 hrs.	.251 in 96 hrs.	.302 in 88 hrs.	.225
Un-Pasteurized	.265 in 55 hrs.	.276 in 72 hrs.	.390 in 64 hrs.	.288 in 48 hrs.

Sample	V	W	X	Y
Pasteurized ...	.050 in 90 hrs.	.226 in 72 hrs.	.214 in 60 hrs.	.213 in 79 hrs.
Un-Pasteurized	.213 in 48 hrs.	.252 in 36 hrs.	.327 in 48 hrs.	.251 in 48 hrs.

Sample	Z
Pasteurized	—.038 in 74 hrs.
Un-Pasteurized	.340 in 50 hrs.

THE ISOLATION OF SPECIES FROM PASTEURIZED MILK.

Many difficulties are encountered in a study of this nature. Only the bacteriologist can appreciate what it means to separate numerous bacteria from milk, work out their history and establish their identity.

Although it was not our aim to work out in sufficient detail to establish identity, for this would require months with each species, it was our lot to study these bacteria isolated, sufficiently to give them identities of their own. It was exceedingly trying to accomplish this, for where there are two or three persistent differential characteristics prevailing between species, and when all other characteristics are in common, the task is important and very complicated.

It has been the growing belief of some workers that where species are practically identical, with the exception of two or three characteristics, they could perhaps be brought under a single species, if the proper conditions were obtained. There is good ground for this opinion which need not be discussed in this connection.

In our work all the different species were studied side by side under the same conditions and cultivated upon the same media so far as it was practicable. If we were to give the history of each showing a single difference and even more, our number of species would be greatly increased, but we have classified together those which seemed closely allied, and could reduce the number still more, but it would probably be to the detriment of our work. Our fear is, we have now overlooked some interesting characteristics because of our desire to reduce the number of species.

We could discuss the relation of some of these species to the hay bacillus, the potato bacillus and others, but because of the indefiniteness of lines of distinction, we must refrain from making any suggestions. The limited histories must convey the importance of the bacteria and the information where they may belong.

Of the 39 varieties isolated and studied together the histories of only 19 varieties will be given, since we think so many of them are near enough alike, but not exactly the same, to be classified together. After the histories have been given of these 19, we shall be inclined to suggest the grouping of others.

The grouping of these bacteria may be represented as follows:

Let the number stand for the laboratory number of the micro-organism and the letter, the sample from which the micro-organism was taken.

Numbers 3, 6, 9, and 12 do not come from any of the samples listed, yet they were taken from Pasteurized milk.

3— , 97—Y.
6— , 12— , 122—P, 123—O, 124—N, 125—Q.
9— , 16—B, 21—C.
29—E.
30—F.
32—H, 40—Z, 82—T, 86—W.
38—I.
43—J.
44—K.
45—M.
46—M.
48—L, 37—G, 64—P, 65—Q, 73—R, 77—S, 81—T.
60—O.
62—P, 57—O.
107—F.

112—G.
115—I.
116—J.
117—L.

NO. 3.

Source.—From Pasteurized milk not recorded in this bulletin. Method of Pasteurizing, same as in first half of samples.

Form and grouping.—Bacillus. Its thickness varies from ¾ m to 1 m; its length from 2¼ m to 6 m. Ends are round. It may form in short threads, but is usually in pairs or single.

Spores.—It forms median spores.

Protoplasm.—The protoplasm of this bacillus is usually homogeneous, but just before sporulation it becomes markedly granular.

Temperature.—Grows best at 28° C. 15° C. checks its growth materially, scarcely developing at all. Withstands 93° C. for 20 min., but is killed at 96° C. for the same time.

Motion.—Very motile. It has a progressive tumbling motion.

Colonies.—The border is irregular and broken, yet its outline is sharp and distinct. Instead of spreading out in a thin plaque, it is rather abrupt. From the border are well-defined lines much darker than the surrounding mass, which run to the center. These markings resemble small crevices extending from the border to the center. At the center there is a dark mass which obliterates all the markings. The whole effect is much like looking down upon a summer rose with its stamens and conglomerate center from which the petals radiate. The color of the colony is dark yellowish brown.

Gelatin tube-cultures.—The growth is slight along the line of inoculation. At the surface it is more noticeable, and it soon begins to liquefy the gelatin. In the liquefaction of the gelatin it has the peculiarity of extending over the entire surface of the tube, but does not extend down the line of inoculation. After liquefying a third the distance down the tube, its growth is checked and it remains apparently inactive, yet after some time the liquefaction extends to the bottom. Quite early in its development a scum forms on the surface of the tube.

Agar inclined tube-cultures.—It spreads over the surface of the agar in a translucent and blister-like mass. From this, after a time, cream-white spots arise.

Bouillon cultures.—A wrinkled scum forms on surface; the liquid beneath is almost clear and there is no sediment at the bottom.

Milk cultures.—Milk is first curdled, then peptonized slowly but completely.

Potato tube cultures.—Blisters resembling water blisters extend over surface. These eventually dry down into a granular mass which finely becomes wrinkled and of a dark brown color.

Blood serum cultures.—Serum is completely peptonized.

Growth.—Rapid.

Pigment.—None.

Oxygen conditions.—Is almost an obligate aërobic bacillus.

Odor.—The odor of rotting potatoes.

Acids.—No acid produced in any of the cultures. Upon the addition of lactose (milk sugar) there was no formation of acid.

Behavior to gelatin.—Liquefies.

Gas production.—None observed even in the presence of carbohydrates.

NO. 6.

Source.—Taken from Pasteurized milk which has not been recorded in this bulletin.

Form and grouping.—A bacillus. Its thickness varies from ¾ m to 1 m; and its length from 3 m to 7 m. It has square ends and is usually arranged in short threads.

Spores.—Forms median spores in old cultures.

Protoplasm.—Homogeneous even to the time of sporulation. Sporogenic granules are not so prominent as many times noticed.

Motion.—It is sluggishly motile. Its movement is that of a snake.

Staining reaction.—Stains readily with ordinary aniline stains.

NOTE.—m stands for Greek letter mu or micron, which is about 1-25,000 of an inch.

Temperature.—Its optimum temperature is 28° C. Scarcely grows at 15° C. Lives at a temperature of 96° C. for 20 min., but is killed at 100° C. for the same time.

Colonies.—The center before liquefaction occurs is bright and glistening and of a very light color, almost translucent. However, it soon becomes liquefied. In the liquid portions are observed small patches of thick masses of bacteria floating about from one place to another. From the circular border radiate fine fiber-like processes which are quite uniform in length and resemble the ray crown.

Gelatin tube-cultures.—At first there is a slight growth along the line of inoculation. After a few hours longer, a funnel-shape liquefaction occurs only at the surface, and this gradually extends across the tube until the upper portion of the tube is liquefied and the lower portion entire. About this time a scum forms on the surface. Having reached this point in its stage of development, its progress is not rapid and the remaining gelatin in the tube is very slow in liquefying.

Agar inclined tube-culture.—A dry spreading growth adhering closely to the agar in a scum-like sheath. Along the streak the growth is much heavier.

Bouillon culture.—Wrinkled dark scum on surface, beneath which the liquid is clear. No sediment forms at the bottom.

Milk cultures.—Milk is at first curdled then peptonized, eventually becomes clear but quite dark.

Potato tube-cultures.—Spreading dirty white growth over surface of potato. It gradually becomes a creamy-white and when it grows old is wrinkled and mealy.

Blood serum tubes.—Serum is peptonized only slightly underneath the growth, which is creamy white.

Growth.—Very rapid.

Pigment.—None.

Oxygen conditions.—Grows best in oxygen, very slightly anaërobically.

Odor.—None perceptible.

Acids.—No acid produced even in presence of carbohydrates. Lactose had no influence in changing this condition.

Behavior to gelatin.—Liquefies gelatine readily.

Gas production.—No gas observed in any of the cultures, not even in presence of carbohydrates.

No. 9.

Source.—Pasteurized milk not recorded in this bulletin; also samples B and C.

Form and grouping.—Its thickness is 1 m to 1¼ m, and its length varies from 3 m to 9 m. Ends are slightly rounded. Forms in long threads, short threads and single.

Spores.—It produces median spores.

Protoplasm.—Homogeneous until the formation of spores at which time it becomes markedly granular.

Motion.—It has a slow progressive and serpentine movement.

Staining reaction.—Stains readily with ordinary aniline stains.

Temperature.—Not killed at 90° C. for 20 min., but killed at 93° C. for 20 min. Scarcely grows at 15° C. Optimum temperature is about 30° C.

Colonies.—At first the colony appears light and crystalline, afterward becoming much darker. Soon after developing it begins to liquefy the surrounding gelatin. From its border is a radiating mass of fine and straight processes but this appearance may be almost completely lost in further liquefaction. The contents of the body as soon as liquefaction begins assume no definite arrangement; patches consisting of masses of bacteria may be seen floating about in the peptonized gelatin. While the above is the usual course of development, the colony may in the early stage of its development resemble a composit flower and again may form in concentric rings of different shades and density.

Gelatin tube-cultures.—The growth is along the entire line of inoculation. Almost as soon as the growth is visible, liquefaction begins and extends to the end of the puncture, liquefying as fast at the bottom of the puncture as at the top. In this way the gelatin is liquefied very rapidly. There is no clearing after liquefaction, the suspended material of a flocculent nature remains as when first formed. The scum which forms on the surface, however, falls eventually to the bottom.

Agar inclined tube-cultures.—It usually spreads over the entire surface in a moist and uniform mass of a creamy white consistency. As the culture becomes old, it dries down in wrinkles.

Bouillon cultures.—Scum forms on top. It is thin and falls to the bottom after a few days. The body of the bouillon remains cloudy and does not become clear.

Potato cultures.—Raised mealy white growth which is not inclined to spread. In this respect, it resembles very closely Bacillus Subtilis.

Milk cultures.—Curdles milk in a very short time, then peptonizes it rapidly.

Blood serum cultures.—Completely peptonizes the serum.

Growth.—Very rapid.

Pigment.—None.

Oxygen conditions.—It seems to grow as readily anaërobically as aërobically.

Odor.—No odor perceptible.

Acids.—No acid produced in any of the cultures, not even when lactose or glucose was added.

Behavior to gelatin.—Liquefies the gelatin very rapidly.

Gas production.—No gas formation observed.

No. 29.

Source.—Was obtained from Pasteurized milk *E*.

Form and grouping.—Its thickness varies from $\frac{1}{2}$ m to $\frac{3}{4}$ m, its length from 2 m to 7 m. The ends are pointed, and the bacilli usually occur in threads of three and four.

Spores.—No spores were observed.

Protoplasm.—The protoplasm is homogeneous and the lines of fission are very distinct.

Motion.—Very actively motile. It has a progressive tumbling motion.

Staining reaction.—Stains readily with ordinary aniline stains.

Temperature.—Withstands 80° C. for 20 min., but is killed at 85° C. for the same time. Its best temperature for growth is 30°-32° C. Below 20° C. it grows very slowly.

Colonies.—The first stage in the development of the colony is a glistening, granular and regularly formed body. As it grows larger, fine and interwoven threads are noticed to proceed from the border extending to some distance into the gelatin. The body of the colony does not verge gradually into the threads but retains its original and definite shape intact through all of its stages of development. The bright glistening appearance remains and the delicate thread like shoots are almost imperceptible.

Gelatin tube-cultures.—The growth is along the entire line of inoculation, simply a streak at first, with perhaps a slightly heavier growth at the surface. The streak gradually widens out into a funnel shape and extends to the bottom of the tube. The growth is a cloudy path through the gelatin and although it appears as liquefied, there is no liquefaction present.

Agar inclined tube-culture.—Almost an invisible sheath covers the surface of the agar along the streak of inoculation. It is translucent, crystalline and moist. There is no spreading over the surface. Isolated colonies may be seen along the streak.

Bouillon cultures.—A homogeneous clouded appearance with a small amount of sediment at the bottom. Does not clear up after several days.

Milk cultures.—Produces an acid but does not change the appearance of the milk. It seems to remain unaffected.

Blood serum cultures.—No change in the serum.

Growth.—Rapid.

Pigment.—None.

Oxygen conditions,—Grows anaërobically nearly as well as aërobically.

Odor.—None.

Acids.—Grown in the presence of lactose, an acid is produced. In litmus-lactose gelatin the litmus is reddened from the surface downward along the growth.

Behavior to gelatin.—Does not liquefy gelatin.

No. 30.

Source.—Pasteurized milk *F*, *H*, *J*, *M*.

Form and grouping.—Bacillus. Its thickness varies from $\frac{1}{2}$ m to 1 m and its length from 2 m to 7 m. Has square ends and is usually single.

Spores.—Median spores are formed. They are quickly set free from the parent cell.

Protoplasm.—Protoplasm maintains a marked homogeneity to time of sporulation.

Motion.—A tumbling progressive movement. Quite rapid.

Staining reaction.—Stains readily with ordinary aniline stains.

Temperature.—Withstands 80° C. for 20 min., but is killed at 85° C. for 20 min. Its optimum temperature is 28° C.–30° C. Below 16° C. it grows very slowly.

Colonies.—It forms in a light brown colony in its first stage. Its border is even and the contour circular. Concentric rings soon appear of different shades of density, and from the border radiate fine thread-like processes. Liquefaction sets in and the outline of the liquefied gelatin is irregular and the colony becomes a nucleated mass with long fibers radiating from the nucleus and extending throughout the liquefied portion. The colony in the last stage has few features left of the first stage. In liquefying, the colony spreads over the surface rather than in a deep cup manner.

Gelatin tube-cultures.—A very slight growth appears along the line of inoculation. At the top the growth soon spreads out in a wide and shallow funnel and finally liquefies the surface of the tube to the depth of a half inch and then apparently stops or grows so slowly that observation ceases. It is evident that the growth is dependent upon the oxygen supply.

Agar inclined tube-culture.—A pearly beaded growth occurs along the line of inoculation; its color is yellowish white. It finally spreads out in a creamy layer over the surface of the agar.

Bouillon cultures.—Cloudiness occurs which does not clear up readily. Small crusty patches appear on the surface, and a small amount of sediment rests at the bottom.

Milk cultures.—Peptonizes milk but slowly. Clears up only after a long time.

Potato tube-cultures.—A yellowish white growth drying down into a wrinkled scum.

Blood serum-cultures.—Peptonized completely.

Growth.—Rapid.

Pigment.—None.

Oxygen conditions.—Requires the presence of free oxygen for growth.

Odor.—Odor of decomposition.

Acids.—No acids produced in the presence of lactose, glucose or in other media.

Behavior to gelatin.—Liquefies rapidly.

No. 32.

Source.—This micro-organism was found in sample *H* of Pasteurized milk.

Form and grouping.—Bacillus. Thickness varies from ½ m to 1 m, and its length from 2 m to 6 m. It does not form threads or pairs.

Spores.—Median spores formed and are quickly set free.

Protoplasm.—The protoplasm is homogeneous, not changing to any great extent at time of sporulation.

Motion.—It has a tumbling progressive motion.

Staining reaction.—Stains readily with the ordinary aniline stains.

Temperature.—Its optimum temperature is 30° C.–32° C. Growth is checked below 15° C. It is killed at 90° C. for 20 min., but withstands 85° C. for the same time.

Colonies.—The colonies are brown and granular at first. The border is regular and well defined. As it grows, there is a thin layer formed over the surface of the gelatin, with an irregular and somewhat indistinct border. At the center is a decided nuclear mass. Developing farther, the gelatin liquefies underneath the colonies, and leaves only the nucleus as a tangible form.

Gelatin tube-cultures.—The growth starts along the whole line of puncture, a little more rapidly at the surface than at the bottom. Liquefaction then sets in at the surface, forming a broad and shallow funnel: at the same time the growth becomes more pronounced along the lower line of inoculation. The whole surface of the tube is finally liquefied to the depth of a third of the tube, and from this point liquefaction is exceedingly slow.

Agar inclined tube-cultures.—It produces a creamy-white and heavy growth along the line of inoculation which spreads out over the surface in scum. As it grows older, wrinkled indentations radiate from the streak.

Bouillon cultures.—A clouded appearance of permanence. Sediment found at bottom in very minute quantities. A few patches of bacteria are seen floating on the surface.

Milk cultures.—Peptonization takes place very slowly.

Potato cultures.—A yellowish white mass appears which dries down into a wrinkled mass.

Blood Serum.—Serum is peptonized completely.

Growth.—Rapid.

Pigment.—None.

Oxygen conditions.—Grows much better in the presence of oxygen.
Odor.—Rotten potato odor.
Acids.—Acid is not produced in any of the cultures—not in the presence of lactose.
Behavior to gelatin.—Liquefies gelatin very rapidly.

No. 38.

Source.—Pasteurized milk I.

Form and grouping.—Bacillus. Its thickness varies from 1 m to 1½ m; its length from 4 m to 10 m. It appears individually and in short threads.

Spores.—Spores are rather slow in developing but median spores appear in an old culture.

Protoplasm.—There is no tendency for the protoplasm to become granular.

Motion.—Very actively motile. Has a progressive snake like motion.

Staining reaction.—Stains readily with ordinary aniline stains.

Temperature.—Grows best at 28° C.-30° C. Withstands 85° C. for 20 min., but is killed at 90° C. for the same time. Grows very slowly indeed below 20° C.

Colonies.—Their first appearance is in yellowish-brown pin-head dots. They are crystalline and bright, with a regular border. Soon they send out root-like shoots from the border which make their way through the gelatin in rapid growth. Each shoot has a knotted aspect, and although they are quite distinct a distance from the colony, yet near the body of the colony they are considerably matted. The regular edge of the original colony is completely lost. The color has become very dark, almost black. Liquefaction is hardly visible.

Gelatin tube-cultures.—The growth is almost wholly at the surface, spreading out upon the surface for a short distance. Just beneath the surface, along the line of inoculation, it sends out branches. The development at the surface and the branches continue to increase until the inverted pine tree appears. The only liquefaction that occurs is directly underneath the colony and that is very limited; only an indentation of the gelatin is it to be noticed.

Agar inclined tube-cultures.—A grayish-white film spreads over the surface. It is moist and almost transparent.

Bouillon cultures.—There is a dense wrinkled scum on the surface; below, the liquid is clear. No sediment appears at the bottom.

Milk cultures.—Milk is completely peptonized, becoming watery.

Potato tube-cultures.—There is a grayish-white blister-like growth which dries down into an irregular mass.

Blood serum cultures.—Serum is completely peptonized.

Growth.—Slow.

Pigment.—None.

Oxygen conditions.—Can adapt itself to anaërobic conditions, but grows best in presence of oxygen.

Acids.—No acids produced even in the presence of lactose or glucose.

Behavior to gelatin.—Liquefies gelatin very slowly.

Remarks.—Some trouble was experienced in making this bacillus grow upon media which seemed very suitable for the others.

No. 43.

Source.—Pasteurized milk J.

Form and grouping.—Bacillus. The thickness of this bacillus varies from ½ m to 1 m; its length from 2 m to 7 m. Its ends are square. The bacilli appear single or in pairs.

Spores.—Median spores are formed.

Protoplasm.—The protoplasm is homogeneous.

Motion.—It has a tumbling and progressive motion.

Staining reaction.—The ordinary aniline stains act readily.

Temperature.—Withstands 93° C. for 20 min., but is killed at 96° C. for the same time. Its optimum temperature is 25° C.-29° C. Grows very slowly below 20° C.

Colonies.—The colony begins as an irregular mass of a very dark color as though the bacteria were massed in a heap. Fine threads soon begin to radiate from this mass and continue to grow till they form a complete whorl. The threads are interwoven with each other and are of a very light crystalline appearance. Liquefaction takes place so slowly that it is not noticeable in the plates.

Gelatin tube-cultures.—The growth may first be seen along the entire line of inoculation. At the surface the growth increases till a small deep cup is formed. It deepens considerably and the surface of the gelatin is slowly liquefied. As soon as the liquefaction extends down a third of an inch, the growth and liquefaction are exceedingly slow.

Agar inclined tube-cultures.—Along the streak there is a creamy white growth which is confined to the limits of the streak.

Bouillon cultures.—An even cloudiness of tube. A small amount of fine sediment occurs at the bottom of the tube. A wrinkled scum forms on the surface.

Milk cultures.—Milk is completely peptonized, yet a milky color remains.

Potato tube-cultures.—A brownish growth which dries down into a thin wrinkled layer.

Blood serum cultures.—Serum is completely peptonized.

Growth.—Rapid.

Pigment.—None.

Oxygen conditions.—Oxygen necessary to its growth. Under anaërobic conditions, very little growth.

Odor.—No marked odor.

Acids.—No acids produced in any of the cultures. Lactose and glucose give rise to none when put into the cultural media.

Behavior to gelatin.—Liquefies very slowly.

NO. 44.

Source.—Taken from Pasteurized milk *K*.

Form and grouping.—Bacillus. Its thickness varies from $\frac{1}{2}$ m to $\frac{5}{8}$ m, and its length from $2\frac{1}{2}$ m to 5 m. The ends are round. It forms in short threads but is usually found single.

Spores.—Median spores are formed.

Protoplasm.—The protoplasm is somewhat granular.

Motion.—It has a very active, progressive, snake-like motion.

Staining reaction.—Stains readily with the ordinary aniline stains.

Temperature.—Optimum temperature is 24°–28° C. Grows very slowly below 18° C. It is killed at 85° C. for 20 min., but withstands 80° C. for the same time.

Colonies.—From the start they resemble a tangle of threads. When quite small there may be noticed several threads of this micro-organism crossing each other. This crossing and recrossing continues until the center is one dense black mass. The threads which were originally single become entangled with each other until several threads unite in forming a large and dense root-like process. Several of these will be found surrounding the colony. The colonies grow to a very large size and their radiating shoots may be readily seen with the naked eye.

Gelatin tube-cultures.—The growth along the line of puncture becomes very marked after a few hours, a little heavier at the surface than at the bottom. Fiber-like processes are soon seen coursing straight out from the line of growth, and these continue to grow till they have nearly reached the tube. These branches or fibers are not uniform throughout their length, but give a knotted appearance. Liquefaction takes place very slowly, only at the surface where it forms a very shallow cup after several days.

Agar inclined tube-cultures.—A slight and almost transparent growth takes place along the line of inoculation. It is moist and soon spreads over the surface of the agar.

Bouillon cultures.—There is a dense wrinkled scum on the surface. The liquid is clear and no sediment appears at the bottom of the tube.

Milk cultures.—The milk is peptonized, but very slowly.

Potato tube-cultures.—A grayish white mass spreads over the surface. It is uneven and scum-like, and finally becomes mealy.

Blood serum-cultures.—Serum is completely peptonized.

Growth.—Fairly rapid.

Pigment.—None.

Oxygen conditions.—Grows both aërobically and anaërobically, but best aërobically.

Odor.—None perceptible.

Acids.—No acid is produced even in the presence of lactose or glucose.

Behavior to gelatin.—Liquefies very slowly.

NO. 45.

Source.—Pasteurized milk *M.*

Form and grouping.—Bacillus. Thickness varies from ½ m to 1 m; its length from 2 m to 7 m. It is found single and in short threads.

Spores.—Median spores are formed.

Protoplasm.—The protoplasm is homogeneous but is decidedly granular just before sporulation.

Motion.—There is a progressive tumbling motion.

Staining reaction.—Stains very readily with ordinary aniline stains.

Temperature.—It withstands 85° C. for 20 min., but is killed at 90° C. for the same time. Its optimum temperature ranges from 23° C.-27° C., and its growth almost ceases below 15° C.

Colonies.—There appears at first a light crystalline mass with a well defined border, which has several short fibers protruding from it. As the colonies grow older, the centers become very dark and the outer zone is only a shade lighter. The border has a dense array of fine fiber-like threads radiating from it, and they are all of nearly uniform length. Liquefaction soon takes place and the colony becomes unrecognizable.

Gelatin tube-cultures.—The growth appears along the entire line of inoculation, but much more rapidly right at the surface, where it slowly spreads out and liquefies, forming a wide shallow cup. It continues to spread at the surface till the whole surface is involved, but does not reach down into the tube. About one-fifth of the tube is liquefied and then it stops.

Agar inclined tube-cultures.—Thick slimy yellowish growth along line of inoculation. There are arms projecting from this line which are short and thick.

Bouillon cultures.—Bouillon becomes densely cloudy with a granular sediment on the bottom and a granular scum on the surface.

Milk cultures.—Milk is peptonized very slowly.

Potato tube-cultures.—A yellowish white growth forming in a wrinkled scum.

Blood serum-cultures.—Serum is completely peptonized.

Growth.—Rapid.

Pigment.—None.

Oxygen conditions.—Free oxygen is essential to growth.

Odor.—No distinguishable odor.

Acids.—No acids produced. Lactose or glucose have no influence

Behavior to gelatin.—Liquefies gelatin rapidly.

NO. 46.

Source.—Pasteurized milk *U.*

Form and grouping.—Bacillus. It has square ends and is usually single, yet short threads are found. Its thickness varies from ½ m to 1 m and its length from 2 m to 7 m.

Spores.—Median spores are formed. On agar, in a few days' time, there seems to be spores only, the vegetative forms have entirely disappeared.

Protoplasm.—The protoplasm is homogeneous, not becoming markedly granular before sporulation.

Motion.—There is a tumbling progressive movement.

Staining reaction.—Take the ordinary aniline stains very readily.

Temperature.—It grows best at a temperature of 28°-30° C. Below 20° C. it grows very slowly. Withstands 93° C. for 20 min., but is killed at 96° C. for the same time.

Colonies.—The young colonies are brown and have an irregular outline. In the middle is a nucleus somewhat darker. From the border are several radiating fibers. As the colonies become older the nucleus remains distinct but the remainder of the colony gradually verges off into a fine misty and fibricated mass, gradually fading away into a single layer of bacteria and only a few threads.

Gelatin tube-cultures.—At first there is a growth along the entire line of inoculation continuing to develop, however, only at the top where a deep cup is formed. The liquefaction soon reaches across the surface of the tube, but does not extend down very far. Just below the liquefied gelatin there are fibers proceeding from the line of inoculation through the solid gelatin.

Agar inclined tube-cultures.—A raised white creamy growth is found along the streak of the needle. It is not inclined to spread.

Bouillon cultures.—Granular patches are found on the surface. The body of the bouillon is evenly clouded, and there is some fine sediment found at the bottom of the tube.

Milk cultures.—Milk is peptonized very rapidly.

Potato tube-cultures.—A yellowish-white growth is obtained which eventually dries into a wrinkled mass.

Blood serum cultures.—Serum is completely peptonized.

Pigment.—None.

Growth.—Rapid.

Oxygen conditions.—Oxygen is required for growth.

Odor.—An old musty odor.

Acids.—No acid is produced even in the presence of lactose or glucose.

Behavior to gelatin.—Liquefies very rapidly.

No. 48.

Source.—This micro-organism was found in sample of Pasteurized milk marked *L.*

Form and grouping.—A bacillus whose thickness varies from $\frac{1}{8}$ m to $\frac{1}{2}$ m, and whose length varies from $\frac{5}{6}$ m to $1\frac{1}{4}$ m. It is found single and in pairs.

Spores.—No spores have been observed.

Protoplasm.—The protoplasm seemed granular in old cultures.

Motion.—No decided motion could be discerned; Brownian motion was present.

Staining reaction.—Stains readily with ordinary aniline stains.

Temperature.—Its optimum temperature is 30° C.–32° C., but below 22° C. it grows very slowly. It remains alive at 80° C. for 20 min., but is killed at 85° C. for the same time.

Colonies.—The colonies at first appear as little dots which are crystalline and bright and have a very well defined border. Later there extends from this border a thin plaque over the surface of the gelatin. It is of almost transparent lightness and is crystalline as the original colony. There is a distinct and even border to this plaque. The colony as a whole has a yellowish tinge.

Gelatin tube-cultures.—The growth extends along the line of puncture, but is heavier at the surface than deep in the tube; yet a heavy growth develops along the entire line of puncture, and there is no liquefaction whatever.

Agar inclined tube-cultures.—Is confined to the streak. It does not form a heavy growth and its color is a light lemon yellow.

Bouillon cultures.—There is an evenly clouded appearance which does not clear. At the bottom is a granular sediment, and at the surface no scum forms.

Milk cultures.—The milk is unchanged in appearance and is acid.

Potato tube-culture.—A lemon yellow growth spreads over the surface of the potato but is not exuberant.

Blood serum-culture.—No change in the serum is apparent.

Growth.—Rapid.

Pigment.—A lemon yellow pigment is produced.

Oxygen conditions.—Grows better in the presence of oxygen and will grow well under anaërobic conditions.

Odor.—No marked odor.

Acids.—Traces of acids produced in the presence of lactose.

Behavior to gelatin.—Gelatin is not liquefied.

No. 60.

Source.—Sample of Pasteurized milk O.

Form and grouping.—Bacillus whose thickness varies from $\frac{1}{8}$ m to $\frac{1}{2}$ m and whose length from 1 m to 2 m. The ends are square. They are usually found in short threads.

Spores.—No spores observed.

Protoplasm.—The protoplasm soon becomes granular. Whether this has any significance in the formation of spores we are unable to say.

Motion.—Only Brownian motion present.

Staining reaction.—Stains readily with the ordinary aniline stains.

Temperature.—Its optimum temperature is 25° C.–30° C., and it grows very slowly below 20° C. 80° C. for 20 min. does not kill, but it succumbs to 85° C. for the same time.

Colonies.—It grows into a colony which is brownish yellow and granular. The borders are regular and sharp. Round in shape and well defined and abrupt borders give the colonies a globular appearance. The colony rests upon and rises above the surface of the gelatin. No sinking or growing into the gelatin occurs.

Gelatin tube cultures.—The growth extends along the line of inoculation in a heavy line without any liquefaction of the gelatin.

Agar inclined tube-cultures.—A moist growth of a creamy consistency follows the line of inoculation upon the surface of the agar. Patches of a denser and whiter growth are found upon the surface of the other growth.

Bouillon cultures.—A very light scum forms on the surface. The liquid remains cloudy and a sediment is found at the bottom of the tube.

Milk cultures.—The milk is curdled only.

Potato tube-cultures.—A slight white and mealy growth appears scattered over the surface of the potato in small patches.

Growth.—Grows very slowly.

Pigment.—There is a perceptible yellowish tinge.

Oxygen conditions.—Grows more readily in the presence of oxygen.

Odor.—No odor.

Acids,—Produces an acid in the presence of lactose.

Behavior to gelatin.—There is no liquefaction.

No. 62.

Source.—Taken from Pasteurized sample Z.

Form and grouping.—Bacillus. Its thickness varies from 1 m to 1¼ m in thickness, and from 2 m to 3 m in length. Its ends are tapering. It is found single but sometimes in pairs.

Spores.—No spores were observed.

Protoplasm.—The protoplasm is homogeneous.

Motion.—It is not actively motile, but when moving its motion is of a tumbling nature.

Staining reaction.—The ordinary aniline stains act readily.

Temperature.—The optimum temperature is placed at 28° C.–32° C., and it grows very slowly below 20°C. 70°C for 20 min. does not kill it, but 75°C for the same time does.

Colonies.—The colonies are bright and glistening, with borders regular and abrupt. The color is yellowish, yet it is changeable to the different reflections. The center is usually lighter than the border. No liquefaction takes place.

Gelatin tube-cultures.—A white growth appears along the line of inoculation and does not spread over the surface.

Agar inclined tubes.—The growth is hardly perceptible; what is seen is scattered over the surface in very small and scanty patches.

Bouillon cultures.—A very fine cloudiness pervades the liquid. There is no scum on the surface and no sediment on the bottom.

Milk cultures.—No change observed.

Potato tube-cultures.—There is no visible growth.

Growth.—Very slow.

Pigment.—No pigment.

Oxygen conditions.—Grows anaërobically and aërobically.

Odor.—No odor.

Acids.—Simply a slight trace of acid formation in the presence of lactose.

Behavior to gelatin.—No liquefaction.

No. 107.

Source.—Taken from changed Pasteurized milk F.

Form and grouping.—Bacillus, the thickness of which varies from 1¼ m to 1¾ m, and the length of which varies from 3 m to 8 m. It is found single and in short threads.

Spores.—Median spores are formed in old cultures, especially on agar.

Protoplasm.—The protoplasm is granular.

Motion.—The motion is progressive but not rapid.

Staining reaction.—It reacts to the ordinary aniline stains very readily.

Temperature.—The optimum temperature is 25° C.–30° C. At 93° C. it remains alive for 20 min., but is killed at 96°C for the same time. Scarcely grows below 20°C.

Colonies.—They appear as little dark round spots at first, which send out from their border filaments, lash like, and which grow through the solid gelatin without any liquefaction. After increasing in size they liquefy quite rapidly, but the colony does not change in general appearances.

Gelatin tube-cultures.—The growth is along the entire line of inoculation, growing better at the surface than deep in the tube. After the growth has become quite heavy along the line of inoculation a number of short stubby processes are given off and the entire growth resembles a pine tree with its limbs cut off six inches from the trunk. Developing still further, the gelatin begins to liquefy and there is a long narrow funnel produced.

Agar inclined tube-cultures.—There is a spreading, raised, wrinkled growth over the surface. The borders are irregular and somewhat crystalline.

Bouillon cultures.—There is a heavy growth, most of which settles in the bottom. Some masses are left suspended in the liquid and the bouillon does not clear readily.

Milk cultures.—The casein is curdled, then peptonized completely and the liquid is dark in color.

Potato tube-cultures.—A grayish white mealy growth spreads over the surface of the potato.

Blood serum cultures.—Serum is completely peptonized.

Growth.—Comparatively slow.

Pigment.—None.

Oxygen conditions.—Grows better in presence of oxygen, but will grow without it.

Odor.—No characteristic odor.

Acids.—Acid is produced in presence of lactose but not without it.

Behavior to gelatin.—Liquefies gelatin.

No. 112.

Source.—Taken from changed Pasteurized milk *G.*

Form and grouping.—Bacillus. Its thickness varies from 1 m to 1½ m and its length 4 m to 12 m. The bacilli are found single and in short threads.

Spores.—Median spores are formed in old cultures on agar.

Protoplasm and cell-wall.—The protoplasm is somewhat granular and the cell-wall shows distinct markings between the cells when formed in threads.

Motion.—Sluggish and serpentine.

Staining reaction.—Stains readily with the ordinarv aniline stains.

Temperature.—It grows best at 26° C.–30° C. Below 15° C. there is no growth at all. 70° C. for one hour does not kill it but 75° C. for 20 min. does.

Colonies.—The center of the colony is dark and without definition, appearing as if made up of a bunch of threads. Its border is ill defined and from it proceed many fine filaments and some heavy lash-like processes. At times the lash-like processes resemble a string of beads.

Gelatin tube-cultures.—There is only a small growth deep in the tube along the line of inoculation; at the surface a shallow cup soon forms from liquefaction and this continues to deepen and widen until a long wide funnel is made and eventually all the gelatin is liquefied.

Agar inclined tube-cultures.—Along the streak forms a series of oval colonies; those at the bottom of the streak are much larger than those at the top. The growth is moist and grayish white.

Bouillon cultures.—Little patches of granular growth are found on the surface. The cloudiness appears granular and is very persistent, only a slight sediment forming on the bottom.

Milk cultures.—The milk loppers and acts much like ordinary souring.

Blood serum cultures.—Heavy white growth on the surface, but it is not peptonized.

Growth.—Rapid.

Pigment.—None.

Oxygen conditions.—Requires oxygen for its development.

Odor.—No odor.

Acids.—Acid is produced in the presence of lactose, but in its absence there is none formed.

Behavior to gelatin.—Liquefies readily.

No. 115.

Source.—Taken from soured Pasteurized milk *I.*
Form and grouping.—Bacillus, the thickness of which varies from 1¼ m to 2 m, and the length from 3 m to 12 m. It is found single and in pairs, sometimes in short threads. The ends are round.
Spores.—Median spores are formed which seem considerably smaller in diameter than the thickness of the cell.
Protoplasm and cell-wall.—It possesses a granular protoplasm. The cell divisions are very distinct.
Motion.—There is a progressive serpentine motion.
Temperature.—Its optimum is 28° C.-32° C. Does not grow below 15° C. It withstands 80° C. for 20 min., but is killed at 85° C. for the same time.
Colonies.—The colonies have a very dark center from which radiate lash-like filaments. As it continues to grow, there are fine processes proceeding from the center also filling in the spaces between the lash-like processes. The latter resemble the "ray crown" somewhat. However the large limbs bar out the perfect "ray crown." Liquefaction begins soon after the fine processes start.
Gelatin tube-cultures.—The growth is along the line of inoculation, developing deep in the tube as well as at the surface. Liquefaction soon begins and it takes place as fast in the lower portion of the tube as at the upper. This continues till all the gelatin is liquefied.
Agar inclined tube-cultures.—A heavy, moist and wrinkled growth spreads over the surface. The borders are irregular.
Bouillon cultures.—No growth on the surface. The cloudiness has a somewhat granular appearance. Sediment is found at the bottom.
Milk cultures.—The milk is peptonized very rapidly and is of a dark color.
Potato tube-cultures.—A dirty white and uneven growth spreads over the surface of the potato.
Growth.—Rapid.
Pigment.—None.
Oxygen conditions.—Will grow without free oxygen.
Acids.—No acid produced even in the presence of lactose and glucose.
Behavior to gelatin.—Liquefies gelatin rapidly.

No. 116.

Source.—Taken from soured Pasteurized milk *J.*
Form and grouping.—Bacillus. Its thickness varies from 1¼ m to 2¼ m, and its length from 2¼ m to 6¾ m. This bacillus forms in short threads. Involution forms are very common in old cultures.
Spores.—Median spores are formed.
Protoplasm.—The protoplasm is homogeneous.
Motion.—It has progressive motion, snake like.
Staining reaction.—Aniline stains react readily.
Temperature.—The optimum temperature varies from 22° C.-28° C. Grows very slowly below 15°. It withstands 85° C. for 20 min., but is killed at 90° C. for the same time.
Colonies.—They begin as light brown spots with well defined borders. Soon fine filaments are seen to proceed from the border and reach out into the gelatin. After a time these filaments become numerous and completely enshroud the body of the colony. The border, however, remains distinct throughout these filamentous changes. The colonies liquefy the gelatin over slowly.
Gelatin tube-cultures.—The growth is along the entire line of puncture but more abundant at the surface. Liquefaction begins at the upper portion and gives rise to a broad, shallow cup, at the lower portion of which the liquefaction continues along the puncture to the bottom of the tube in a narrow funnel. From this stage the liquefaction continues until the entire gelatin is liquefied.
Agar inclined tube-cultures.—A moist, heavy and wrinkled growth spreads over the surface of the gelatin. The color is a brownish white.
Bouillon cultures.—No growth is formed on the surface. The cloudy liquid, instead of clearing, remains impregnated with a flocculent substance. At the bottom is a sediment.
Milk cultures.—The milk is rapidly peptonized. Instead of leaving a clear fluid, it is filled with a flocculent substance.

Potato tube-cultures.—A moist grayish white growth appears which dries down into a mealy mass.
Growth.—Rapid.
Pigment.—None.
Oxygen conditions.—It will grow without the presence of free oxygen, but the growth is somewhat restrained.
Odor.—A disagreeble odor.
Acids.—No acids produced in any of the cultures, even in the presence of loctose or glucose.
Behavior to gelatin.—Liquefies.

No. 117.

Source.—Taken from changed Pasteurized milk *L.*
Form and grouping.—Bacillus. Its length varies from 1 m to 1¼ m, and its length from 3 m to 9 m. It is found single and in threads of different lengths. The ends are round.
Spores.—Median spores are developed.
Protoplasm.—The protoplasm is granular.
Motion.—It has a progressive serpentine motion.
Staining reaction.—Ordinary aniline stains react readily.
Temperature.—Its optimum temperature is 25° C.–30° C. It is not killed at 80° C. for 20 min., but is killed at 85° for the same time. Develops very slowly below 16° C.
Colonies.—The body of the colony is light brown and the border is irregular. From the border radiate fine filaments which form a dense net work about the colony.
Gelatin tube-cultures.—The growth is along the entire line of inoculation; the growth is as heavy at the bottom as at the top. In liquefying the funnel formed has straight sides and reaches nearly to the bottom of the tube. The gelatin is gradually liquefied.
Agar inclined tube-cultures.—A heavy, moist and wrinkled growth spreads over the surface of the agar, the border of which is serrated.
Bouillon cultures.—A greasy thin growth forms on the surface. The cloudiness is evenly distributed and some sediment may be found at the bottom.
Milk cultures.—The milk is first loppered, then peptonized.
Potato tube-culture.—
Blood serum-culture.—Serum is completely peptonized.
Growth.—Rapid.
Pigment.—None.
Oxygen conditions.—Grows anaërobically as well as aërobically.
Odor.—
Acids.—Acid is produced in the presence of lactose.
Behavior to gelatin.—Liquefies.

After reviewing the histories and bearing in mind the appearances of these bacteria, it seems possible that numbers 30, 32, 43, 45, 46 might be a single species, notwithstanding marked differential features when growing side by side under the same conditions. This too may be said of 107, 112, and 115; also of 116 and 117. This may be true of other combinations. This, however, is a study by itself and months of work may not reveal any satisfactory results, if we are to judge from the time and work put upon the differentation of Eberth's bacillus and the Colon bacillus or bacilli. Although we are unable to make a satisfactory statement in regard to species, we hope that this phase of the work will not detract from the value of the remainder.

2. Determining the Source of Such Bacteria.

No exhaustive work has been pursued in this connection. Our purpose was simply to ascertain where these resistant bacteria may have their source or where they may be found before reaching the milk.

Numerous plates were made from the dust floating in the air of the stable, from the particles of filth falling from the nether regions of a cow and her udder, and from the milk house or dairy. By means of the apparatus described in Bulletin 140, p. 101, the milk from the milk duct was studied.

After the plates made from these different sources had developed, the colonies were studied closely and bouillon cultures made from the different kinds. These were subjected to the stated Pasteurization after they had grown for several days, and two or three days after Pasteurizing, transplantations were made into sterile bouillon tubes, using three platinum loopfuls for each inoculation. If any of these latter tubes developed, they were regarded as bacteria resistant to Pasteurization.

This work may be tabulated as follows:

In the dust from the stable, 2 were found out of 20.

In the dirt from the cow, 2 were found out of 24.

In the dust from the dairy, 1 was found out of 15.

In the fore milk of the milk-duct, 3 were found out of 25.

From this we may expect to find resistant bacteria in the dust of the stable, in the filth from the cow, in the dust of the dairy and in the milk-duct of the teat; in fact, we may expect them from almost any source to which the milk is exposed.

3. The Study of Their Actions Upon Milk.

What the bacteria may do when left after Pasteurizing is interesting, because it has been supposed that the lactic acid bacteria have been killed. This is largely true but not universally. The keeping quality of the milk is only slightly enhanced, and yet the changes which follow Pasteurization are markedly different. Normally, milk sours from the growth of the lactic acid bacteria, but when these bacteria are killed other varieties act and most of these may be said to peptonize or digest the casein of the milk, making the milk as clear as water. This digestion is simply the conversion of the insoluble casein into the soluble form caseon. Before this digestion, in some cases, the milk is curdled by a ferment secreted by the bacteria. Again, the milk is curdled by acid formation without any digestion, as in the usual lactic acid fermentation. A few bacteria are found which produce no change whatever to the naked eye.

The following tables will illustrate the different actions of the species isolated:

+ = Affirmative.
— = Negative.

Those bacteria which curdle the milk only.

3	6	9	29	30	32	38	43	44	45	46	48	60
—	—	—	—	—	—	—	—	—	—	—	—	+

62	107	112	115	116	117
—	—	+	—	—	—

Those bacteria which peptonize or digest the casein.

3	6	9	29	30	33	38	43	44	45	46	48	60
+	+	+	—	+	+	+	+	+	+	+	—	—
62	107	112	115	116	117							
—	+	—	+	+	+							

Those bacteria which curdle then peptonize the casein.

3	6	9	29	30	32	38	43	44	45	46	48	60
+	+	+	—	—	—	—	—	—	—	—	—	—
62	107	112	115	116	117							
—	+	—	—	—	+							

Those bacteria which produce an acid.

3	6	9	29	30	32	38	43	44	45	46	48	60
—	—	—	+	—	—	—	—	—	—	—	+	+
62	107	112	115	116	117							
+	+	+	—	—	+							

Those bacteria which produce no perceptible change in milk.

3	6	9	29	30	32	38	43	44	45	46	48	60
—	—	—	+	—	—	—	—	—	—	—	+	—
62	107	112	115	116	117							
+	—	—	—	—	—							

4. The Investigation of the Thermal Death-Points of the Species Isolated.

It is generally recognized that there are always left after Pasteurization many resistant bacteria, and it has been suggested that by a moderate elevation of the temperature, these might be killed.

From a perusal of the thermal-death-points of the species isolated, it will be easily seen that a slight elevation of temperature would have little effect and that the temperature employed was sufficiently high to accomplish its purpose, if the pathogenic bacteria were also killed.

A special experiment was made with the tubercle bacillus. Tuberculous material was taken from an animal affected with tuberculosis, and was thoroughly mixed in milk. Part of the milk so treated was heated at 68° C. for 20 minutes, then injected into guinea pigs, 3 in number; the other part was injected into a guinea pig without heating. The three pigs did not contract tuberculosis while the one did. This experiment will be reported in a bulletin on tuberculosis, but this is sufficient to show that the heating at 68° C. for 20 minutes was fatal to the bacillus. [*This must not be considered conclusive. Author.*]

The following table will illustrate the resistance of the bacteria isolated from Pasteurized milk.

The temperatures are centigrade and the marks. plus denotes resistance to the temperature and minus denotes killed at the temperature.

No. of micro-organisms.	70° for 20 min.	70° for 30 min.	70° for 1 hour.	75° for 20 min.	80° for 20 min.	85° for 20 min.	90° for 20 min.	90° for 20 min.	93° for 20 min.	96° for 20 min.	100° for 20 min.
3	+	+	+	+	+	+	+	+	+	−	−
6	+	+	+	+	+	+	+	+	+	+	−
9	+	+	+	+	+	+	+	+	−	−	−
29	+	+	+	+	+	−	−	−	−	−	−
30	+	+	+	+	+	−	−	−	−	−	−
32	+	+	+	+	+	+	−	−	−	−	−
38	+	+	+	+	+	+	−	−	−	−	−
43	+	+	+	+	+	+	+	+	+	−	−
44	+	+	+	+	+	−	−	−	−	−	−
45	+	+	+	+	+	+	−	−	−	−	−
46	+	+	+	+	+	+	+	+	+	−	−
48	+	+	+	+	+	−	−	−	−	−	−
60	+	+	+	+	+	−	−	−	−	−	−
62	+	+	+	−	−	−	−	−	−	−	−
107	+	+	+	+	+	+	+	+	+	−	−
112	+	+	+	−	−	−	−	−	−	−	−
115	+	+	+	+	+	−	−	−	−	−	−
116	+	+	+	+	+	+	−	−	−	−	−
117	+	+	+	+	+	−	−	−	−	−	−

5. The Effect of Sudden Cooling After Pasteurization Upon the Species Isolated.

It has been stated by certain writers that sudden cooling was essential to stun the bacteria. Others say that if the cooling is rapid enough to stay the multiplication of bacteria, that is all that is required. To gain the real value of sudden cooling upon the milk bacteria isolated, the author selected six varieties showing the widest differences for this test.

Bouillon cultures were made and allowed to stand a few days for spore formation, then they were subjected to Pasteurization. After Pasteurization, one tube of each species was cooled suddenly to 8° C. [46° F.] and one tube was allowed to cool to the temperature of the room gradually. As soon as each had reached its desired temperature, fresh sterile bouillon was inoculated, one tube from each and three platinum loopfuls for each tube. They were placed away side by side at room temperature for development. When there were the first traces of growth, the time was noted. Five tests of each variety were made in this manner and the results noted as in the following table:

No. of micro-organisms.	First test.				Second test.				Third test.				Fourth test.				Fifth test.			
	Cultures.* Hours.	Controls.† Hours.	Cooled ‡ Hours.	Non-cooled.‖ Hours.	Cultures. Hours.	Controls. Hours.	Cooled. Hours.	Non-cooled. Hours.	Cultures. Hours.	Controls. Hours.	Cooled. Hours.	Non-cooled. Hours.	Cultures. Hours.	Controls. Hours.	Cooled. Hours.	Non-cooled. Hours.	Cultures. Hours.	Controls. Hours.	Cooled. Hours.	Non-cooled. Hours.
3	48	33	67	75	95	28	48	67	117	24	54	46	140	29	45	45	164	21	46	46
21	48	25	51	57	95	20	29	48	117	24	31	26	140	24	28	45	164	7	29	30
30	48	33	58	67	95	20	68	53	117	26	46	31	140	24	45	45	164	6	29	29
48	48	46	95	100	95	53	68	76	117	46	56	54	140	45	94	70	164	46	119	94
107	48	25	43	51	95	20	----	--	117	24	31	32	140	24	29	29	164	7	29	29
116	48	25	47	93	95	22	53	28	117	24	31	26	140	24	45	29	164	7	46	29

* Cultures—refers to the age of the culture used in Pasteurization.
† Controls—cultures made at the same time as those Pasteurized but put away for development.
‡ Cooled—cultures Pasteurized and suddenly cooled.
‖ Non-cooled—cultures Pasteurized and allowed to cool gradually.

In this work 10 cultures of the suddenly cooled exceeded the time of development of the non-cooled; 12 cultures of the non-cooled or cooled gradually, exceeded the time of development of th cooled; 6 cultures of the suddenly cooled developed in the same time as the non-cooled. Sudden cooling seems to have no effect on the time of development.

6. THE RESTRAINING INFLUENCE OF COLD UPON THE SPECIES ISOLATED.

Cold always retards the development of bacteria. This is clearly shown upon the species in question by the table below:

No. of micro-organisms.	First test.				Second test.				Third test.				Fourth test.				Fifth test.			
	Cultures.* Days.	Controls.† Days.	Cooled.‡ Days.	Non-cooled.‖ Days.	Cultures. Days.	Controls. Days.	Cooled. Days.	Non-cooled. Days.	Cultures. Days.	Controls. Days.	Cooled. Days.	Non-cooled. Days.	Cultures. Days.	Controls. Days.	Cooled. Days.	Non-cooled. Days.	Cultures. Days.	Controls. Days.	Cooled. Days.	Non-cooled. Days.
3	6	25	38	----	7	----	----	----	3	17	----	----	4	26	----	----	5	----	----	----
21	6	14	45	45	7	25	----	----	3	43	27	----	4	42	----	----	5	22	----	----
30	6	----	45	----	7	----	----	----	3	----	----	----	4	----	----	----	5	----	----	----
48	6	8	19	21	7	15	25	25	3	----	24	----	4	13	23	42	5	17	27	25
107	6	----	----	----	7	----	----	----	3	----	----	----	4	----	----	----	5	----	----	----
116	6	26	28	----	7	----	----	----	3	27	----	----	4	42	----	----	5	22	41	----

* Cultures—age of cultures when Pasteurized.
† Controls—cultures made at the same time as those Pasteurized, but placed at room temperature instead of refrigerator temperature.
‡ Cooled—cultures Pasteurized, suddenly cooled and placed in the refrigerator at 15° C.
‖ Non-cooled—cultures Pasteurized, gradually cooled and placed in the refrigerator at 15° C.
The blank spaces indicate no growth after 45 days.

Sudden cooling apparently had no effect in the case of refrigerator temperature 15° C. [59° F.], but the constant cool temperature retarded greatly the growth of these micro-organisms.

To make this thoroughly applicable, six miscellaneous micro-organisms were treated in the same way as the previous set but were not subjected to Pasteurization. Here it will be noticed that the time of development is much less, but the refrigerator temperature retarded the growth by several days. The table will explain itself.

No. of micro-organisms.	First test.		Second test.		Third test.		Fourth test.		Fifth test.	
	Controls.*	Refrigerator cultures.†	Controls.	Refrigerator cultures.	Controls.	Refrigerator cultures.	Controls.	Refrigerator cultures.	Controls.	Refrigerator cultures.
126	1	4	1	4	1	3	1	4	1	3
128	1	4	1	4	1	3	1	4	1	3
129	1	8	1	3	1	2	1	2	1	3
134	1	8	1	8	1	2	1	2	1	3
136	1	8	1	7	1	5	1	4	1	6
138	1	4	1	4	1	2	1	2	1	3

* *Controls* kept at temperature of room.
† *Refrigerator cultures*—those inoculated then placed in refrigerator.

7. The Restraining Influence of Heat Upon the Species Isolated.

This subject has been repeatedly illustrated, yet it may be profitable to append a table illustrating this point. The method was identical with that employed under No. 5 and in fact was a part of it; that is, bouillon tubes were inoculated from cultures, one set was Pasteurized and the other set untouched. From these sets fresh bouillon tubes were inoculated and the time of development was recorded in the following table:

No. of micro-organisms.	First test.		Second test.		Third test.		Fourth test.		Fifth test.	
	Cultures unheated. Hours.	Cultures heated. Hours.	Cultures unheated. Hours.	Cultures heated. Hours.	Cultures unheated. Hours.	Cultures heated. Hours.	Cultures unheated. Hours.	Cultures heated. Hours.	Cultures unheated. Hours.	Cultures heated. Hours.
3	33	75	28	67	24	46	29	45	21	46
21	25	57	20	48	24	26	24	45	7	30
30	33	67	28	53	26	31	24	45	6	29
48	46	100	53	76	46	54	45	70	46	94
107	25	51	20	--------	24	32	24	29	7	29
116	25	93	22	28	24	26	24	29	7	29

8. The Restraining Influence of Heat Followed by a Low Temperature Upon the Species Isolated.

There is little difference between Nos. 7 and 8; yet there may be considerable importance attached to the following of Pasteurization by a low degree of temperature. It is asserted that bacteria in the spore form require a higher degree of temperature for development than when in the vegetative form. Of the bacteria isolated, the following table will state whether spores were observed. Plus is affirmative and minus negative.

No. of micro-organisms:—

3	6	9	29	30	32	38	43	44	45	46	48	60
+	+	+	—	+	+	+	+	+	+	+	—	—
62	107	112	115	116	117							
—	+	+	+	+	+							

This table is by no means conclusive, for those in which the spores were not observed may, under conditions not studied, produce spores. Careful attention was given to the formation of spores.

Now we are ready to give our table illustrating the restraining influence of heat followed by a continuous low temperature. Bouillon tubes were used as in previous cases because of the easy recognition of

development. We have shown that heat restrains the growth considerably even when placed in favorable temperature for development. It appears to me that by contrasting this table with the table illustrating the time of development in the refrigerator, we shall have gained the desired knowledge. Blank spaces had not developed in 45 days.

No. of micro-organisms.	First test.			Second test.			Third test.			Fourth test.			Fifth test.		
	Cultures unheated. Hours.	Cultures heated. Hours.	Cultures heated and refrigerator. Days.	Cultures unheated. Hours.	Cultures heated. Hours.	Cultures heated and refrigerator. Days.	Cultures unheated. Hours.	Cultures heated. Hours.	Cultures heated and refrigerator. Days.	Cultures unheated. Hours.	Cultures heated. Hours.	Cultures heated and refrigerator. Days.	Cultures unheated. Hours.	Cultures heated. Hours.	Cultures heated and refrigerator. Days.
3	33	75	......	28	67	......	24	46	......	29	45	......	21	46	......
21	25	57	45	20	48	......	24	26	......	24	45	......	7	30	......
30	33	67	......	20	53	......	26	31	......	24	45	......	6	29	......
48	46	100	21	53	76	25	46	54	......	45	70	42	46	94	25
107	25	51	......	20	......	......	24	32	......	24	29	......	7	29	......
116	25	93	......	22	28	......	24	26	......	24	29	......	7	29	......

9. Suggestions as to the Reduction of Infection.

Owing to the fact that these resistant bacteria are found in the milk ducts, in the filth of the barn and in the dairy, I can only advise the general recommendations made in the bulletin preceding this. In successful dairying, cleanliness must be observed.

10. The Value of Pasteurization.

Pasteurization has for its objects, the reduction of the number of bacteria, the enhancing of the keeping quality, and the killing or devitalizing of pathogenic bacteria.

It is true that the number of bacteria is considerably reduced; but the reduction in the number of harmless bacteria cannot be a practical gain especially when these bacteria (lactic acid bacteria) are more desirable than those that remain. The lactic acid bacteria check the growth of other bacteria by the formation of acid. If those bacteria remaining after Pasteurization (mostly peptonizing bacteria) are allowed to grow for a sufficiently long time, they may produce substances which are not only detrimental many times to the animal economy but even poisonous. Guinea pigs have been poisoned with the products of these bacteria. A single experiment will illustrate this point. A culture of one of the peptonizing bacteria in milk was taken after the milk had been completely peptonized and made slightly acid with acetic acid. It was filtered and evaporated to a syrupy mass, when it was extracted with alcohol and the alcohol extract evaporated to dryness. The residue was dissolved in the least possible amount of distilled water. One cubic centimeter of this solution killed a guinea pig in a few hours.

The enhancing of the keeping qualities is not great enough to warrant Pasteurization; for even Pasteurized milk must be used within two or three days to be fresh and palatable. Ordinary milk will keep as long as this, when placed upon ice the same as Pasteurized milk.

The whole value of Pasteurized milk lies in its absence from danger of pathogenic [disease-producing] bacteria. This is, however, important enough to warrant its use, both on account of the prevalence of tuberculosis and typhoid fever. Too much stress cannot be placed upon it in the preparation of milk for children. Intestinal disorders are so common with them and so many disorders are attributable to bacteria that every precaution should be observed. For the Pasteurizing of milk in small quantities, I know of no better apparatus than that of Dr. DeSchweinitz, described in Bulletin 134, p. 33, of this station.

I wish to acknowledge my appreciation for the valuable suggestions of Prof. C. D. Smith and Mr. G. H. True and also to state that Mr. G. H. True Pasteurized all of the samples used.

BULLETIN 148

SEPTEMBER, 1897

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

HORTICULTURAL DEPARTMENT

STRAWBERRIES

By L. R. TAFT and H. P. GLADDEN

AGRICULTURAL COLLEGE, MICHIGAN
1897

BULLETIN 148 SEPTEMBER, 1897

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The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.

STRAWBERRIES.

L. R. TAFT AND H. P. GLADDEN.

The season of 1896 was very favorable for plant growth and most varieties were in good condition to bear a large crop of fruit last spring. The season of 1897 was two weeks later than that of the previous year, and the plants which had been held back by the cold spells came into bloom very quickly, and so many blossoms came out that the plants were not able to produce sufficient pollen to properly fertilize all the fruits. Many staminate sorts appeared almost imperfect in flower. Doubtless, the small crop borne by some sorts and the great number of imperfect berries was due to the excessive blossoming. The difference between the time of ripening of the early and late sorts was not so great as usual. When the season opened all varieties came on together.

The table (page 52) was compiled from plants set in 1896. Each variety was given forty feet of space in the row; in one-half of this distance the plants were grown in hills (thirteen); in the other portion the plants were allowed to form a matted row. In nearly every case the largest yield was obtained from the matted rows.

The following sorts fruited here for the first time during the past season:

Anna Kennedy.—Received from J. T. Lovett Co., Little Silver, N. J. Imperfect flower. The variety is fairly vigorous in plant growth, with bright, healthy foliage. The berries are of good size, very regular in form and they have a bright, glossy appearance that makes them attractive for market. In quality it ranks high and seems to possess the necessary firmness to hold up well. The plants retain their vigor to close of season and the last fruits are of good size and form. Were the variety more productive it would find a place as one of the better sorts for market or home use.

Annie Laurie.—From Matthew Crawford, Cuyahoga Falls, Ohio. Perfect flower. The plants are of low, stocky growth, and seem somewhat subject to blight. The berries are usually large, round conical in form and of a bright, glossy scarlet color. In quality and firmness of fruit the variety ranks very high, but seems to lack the plant qualities necessary to produce a large crop of berries.

daily, requires 23.57 pounds of dry matter, 2.06 pounds of digestible protein, 12.50 pounds of digestible carbohydrates, and .89 pounds of digestible fat.

A discussion of some of the feeding stuffs used at the College follows, in which the results of many experiments are briefly reported.

Sorghum and kaffir corn yielded large amounts of forage per acre, in which the per cent of dry matter was lower than in corn and the protein content was conspicuously low. Neither is recommended as a substitute for corn.

Clover hay is valuable because supplying a large per cent of protein, and because deriving its nitrogen largely from the air. After the removal of the crop of hay, as much nitrogen was left in the roots as would be supplied by 7 tons of barnyard manure per acre. Clover silage is palatable to cows but the method of ensiloing clover is not recommended because of the expense.

Vetches, crimson clover, peas, and alfalfa were grown and the results are reported.

Roots are recommended, the plot experiments showing the greatest return in dry matter per acre by sugar beets, with rutabagas second and carrots third. The labor in growing and harvesting an acre of roots is shown to be 32.8 hours for man and team and 209.9 hours for man. The addition of roots to a ration of clover hay, corn meal and wheat bran was shown to affect the digestibility of certain factors. More of the N. free extract, crude fiber, ash and dry matter were digested when mangolds were fed than when the ration was fed without succulent foods. The addition of potatoes instead of roots increased the digestibility of the N. free extract, but decreased the digestibility of the protein, crude fiber, fat and total dry matter.

The addition of potatoes to a normal ration increased the length of time required to churn the cream and in one experiment increased the hardness of the butter.

Seventeen analyses of bran show that the composition of burr stone bran differs from the product of the roller process in containing less fat. A sample of first grade bran, so called, contains nearly two per cent more protein than either the second or third grade.

A description of a new and cheap dairy barn concludes the bulletin.

DEFINITION OF TERMS.

There are a few terms used in the literature relating to cattle feeding the meaning of which ought to be clearly understood. Among these terms are dry matter, protein, carbohydrates, and digestibility.

All of our cattle foods, no matter how dry they may seem, contain water. If first dried in the open air, then pulverized and exposed for a longer period to a perfectly dry atmosphere and a low heat, it is easy to understand that nearly, if not quite, all the water in the original substance would be driven off and the residue would be rightly called dry matter. The water which was driven off by the heat and taken up by the air has no value for feeding purposes, whether it comes from hay or from mangolds or turnips. Roots are not valuable because they contain water, but because of the amount and composition of the dry matter that

would be left were all the water dried out of them. In the comparison of stock foods, then, the only fair basis is the dry matter which they contain.

The meaning of the word *protein* is a little harder to illustrate. A reference to the diet of human beings may aid in making its significance clear. No dinner seems complete without some kind of meat. Lean meat contains in the first place a large amount of water. If this were driven off, the dry matter would be found to consist of the red muscle, fat and a small amount of connective tissue. It is the red muscular tissue that is the characteristic constituent of lean meat. If meat is wanting, the house wife finds it possible to supply its place with eggs. One hundred pounds of eggs contain not far from sixty-six pounds of water, 9.5 pounds of fat and 13 pounds of albumen, a material having a chemical composition very similar if not identical with that of the dry, red muscle of lean meat. If eggs were not obtainable as a substitute for meat, its place might be acceptably filled by a sufficient quantity of cheese. One hundred pounds of Cheddar cheese contain 35.6 pounds of water, 32 pounds of fat and 28.2 pounds of casein, a substance having also a chemical composition very similar to that of the dry lean muscle of lean meat. Now this class of substances to which belong dry lean meat, the albumen of the white of eggs, and the casein of cheese, is called *protein.*

All of our cattle foods contain compounds having a composition similar to the protein of lean meat, eggs and cheese and serving for our domestic animals the same purpose that the protein of meat, cheese and eggs does for human beings.

It must not be understood that meat and eggs and cheese are the only articles of human diet that furnish protein. The truth is far otherwise. While meat and some animal products have a larger proportion of protein than do most vegetables, the latter are by no means wanting in it. Even potatoes, a very starchy food, contain, when boiled, on the average, 2.7 pounds of protein for every hundred pounds of gross weight. Beans have a much larger per cent of protein, on the average 21.81 pounds to the hundred weight. White bread contains 9.5 per cent of this valuable nutrient. The limited number of experiments that have been tried on this point lead us to believe that a pound of protein derived from potatoes is equally as valuable as the same amount derived from lean meat, though this point has not been well established.

Turning now to cattle foods, there are some of them that may be supposed to be related to the appetite of the cow in the same way that eggs, cheese and meat are to the appetite of men. To this class of cattle foods would belong such materials as cotton seed meal, linseed meal, buckwheat middlings, and possibly wheat bran and middlings. One hundred pounds of cotton seed meal contain 42.4 pounds of protein while the same weight of cheese would have but 28.2 pounds. Linseed meal, old process, has in each hundred pounds 32.9 pounds of protein while eggs, the typical proteid substance of the human dietary, contains but 13.1 pounds of protein per hundred weight. Men eat eggs and meat because the protein they contain satisfies hunger for that ingredient. So the appetite of the cow calls for materials containing protein and is satisfied when fed on relatively small quantities of feeding stuffs of this class rich in protein.

Chemical examination has shown that protein contains on the average about 16 per cent of the element nitrogen, and that protein compounds are quite uniform in this respect. Because of this fact the protein compounds of cattle feeding stuffs are called not infrequently nitrogenous compounds.

Fat.—The meaning of the word fat in relation to cattle feeding is the same as when used in ordinary conversation. The fat found by the chemist to exist in clover hay, corn meal, and other feeding stuffs is very similar in composition to animal fat like lard, butter fat or tallow. The quantity of fat existing in the various feeding stuffs varies within very wide limits. Of the total weight of the seeds of the flax and the cotton plants fully one quarter is oil, while mangolds, straw and green fodders contain relatively little fat. The fact that nearly all of our fodders do contain fat is the one which it is important to remember.

Carbohydrates.—Both protein and fat are essential constituents of the diet of mankind. But not a single meal would be deemed complete in this latitude if it consisted wholly of a combination of these two nutrients. The appetite calls for some starchy food. This is usually supplied by potatoes or some other vegetable. Boiled potatoes are composed of approximately the following constituents in the proportions, indicated: water, 73.7 per cent; protein, 2.7 per cent; fat, .2 per cent; and starch 22.3 per cent. Honey and syrups are composed almost entirely of sugar. In the animal economy it has been pretty clearly shown that the sugar and starch serve as a source of energy. For reasons that need not be discussed here the chemists have used the term carbohydrates as the name of the class of nutrients which includes both starch and sugar.

In cattle feeding the materials with which we have to deal contain a large proportion of fibrous material. These woody matters are digested to some extent in the intestines of the cow. The chemist distinguishes between the crude fiber of the forage crops and the more soluble starch and sugar and similar compounds. The former he calls crude fiber, and the latter, nitrogen-free extract because containing no nitrogen. As far as digested, however, all of these materials are equivalent to starch, and in the following discussions the digestible crude fiber will be reckoned under the general term of carbohydrates. In the human diet the potato stands well up in the list of the articles furnishing the most carbohydrates since it contains, when boiled, 22.3 per cent of starch and other carbohydrates. Other vegetables are also relatively rich in starch, sugar and woody fiber all of which are carbohydrates. In cattle foods our common field-cured fodder corn contains per hundred weight, 36.5 pounds of the soluble carbohydrates, called by the chemist nitrogen-free extract, and 22.1 pounds of the less soluble but still partly digestible crude fiber, both are, of course, carbohydrates.

Carbohydrates make up the bulk of the stems and leaves of our forage crops and are the principal constituents of our grain feeds as well.

Ash.—The ashes remaining when a feeding stuff is burned have a certain part to play in the nutrition of animals. While there is usually no lack in ordinary feeding of this constituent of fodder, sometimes in the case of young animals fed very largely on grain as in the case of pigs fed on corn, the lack of the ash element shows itself in the weak bony structure of the animal and in a general lack of thrift.

Digestibility.—While the stomach and intestines of the dairy cow are especially adapted to the digestion of coarse feed, a share of the valuable parts passes through her without digestion. All of the materials we have described, the protein, the carbohydrates and fat, are more or less encased in toughened cells in such a way as to prevent the ready access of the fluids of the stomach and bowels. Were it not for the very large stomach of the cow in which her food soaks in liquids which soften it for the second grinding it receives when she chews her cud, and for the great length of her intestinal canal varying from twelve to twenty times the length of her body, nearly all of the coarser parts of the forage crops must escape digestion. As it is, with this complicated and effective apparatus, which nature has provided, but little more than half of some of the valuable nutrients of the forage crops are absorbed into the circulation of the cow and became really useful to her.

To determine what share of the food consumed is really digested by the cow, extensive experiments have been performed both in the Old World and in this country.

The first step in one of these digestion experiments is by chemical analysis to find out how much protein, carbohydrates and fat one hundred pounds of the food stuff in question contains. Two animals are then weighed daily for a week and fed a weighed daily ration of the material to be tested. At the end of that time the real experiment begins. The animals are weighed daily for the next period, usually of six or seven days, and both the amount of food they consume and the amount of excrement they void are carefully weighed and analyzed. From the data thus obtained, the amount of protein, carbohydrates and fat digested is found by subtracting the amounts of each in the dung from the amounts of each in the feed which the animals consume, in the given time. For instance suppose it was desired to determine what share of the nutrients, protein, carbohydrates and fat, cattle were able to extract from clover hay and utilize in their bodies. Two steers would be fed clover hay for a week, the ration being so regulated that there would be neither gain nor loss in weight. Let us next suppose that the following period of the experiment was six days, and that in that time each steer consumed twenty pounds per day of clover hay. The clover hay would contain as shown by chemical analysis per hundred pounds

Water	15.3 pounds.
Ash	6 2 pounds.
Protein	12 3 pounds.
Crude fiber	24 8 pounds.
Nitrogen-free extract	38 1 pounds.
Fat	3 3 pounds.
	100 00 pounds.

In the six days, each steer would consume 120 pounds of clover hay, containing according to this analysis 14.76 pounds of protein. For, if one hundred pounds of hay contained 12.3 pounds of protein, one pound of hay would contain .123 pounds which, multiplied by 120 gives 14.76, as the total amount of protein in the 120 pounds of clover hay consumed in the six days. By using the table of analysis in this way we find that in the 120 pounds of clover hay there would be, besides the 14.76 pounds of protein, 29.76 pounds of crude fiber, 45.72 pounds of soluble carbo-

hydrates, or nitrogen-free extract as they are here called, and 3.96 pounds of fat.

Let us suppose next that the dung for these six days is weighed, sampled and analyzed. It would weigh not far from 25 pounds per day per steer, or 150 pounds for the six days. A chemical analysis would show that this dung contained, per hundred pounds, 4.702 pounds of protein, 10.55 pounds of crude fiber, 11.89 pounds of nitrogen-free extract and 1.373 pounds of fat. The hundred and fifty pounds of this material would contain 7.08 pounds of protein, 15.77 pounds of crude fiber, and 17.83 pounds of nitrogen-free extract and 2.06 pounds of fat. These materials having passed through the body and been excreted from it unaltered, could not have been digested. If therefore, we subtract the amounts of each nutrient in the dung from the amounts of the same material in the food consumed we shall have the amount digested, the amount taken out of the food by the digestive organs of the animal and utilized in its growth or maintenance. This is done in the following table.

	Protein.	Crude fiber.	N. free extract.	Fat.
	lbs.	lbs.	lbs.	lbs.
In 120 pounds hay	14.76	29.76	45.72	3.96
In the 150 pounds dung	7.08	15.77	17.83	2.06
Amounts digested	7.68	13.99	27.89	1.90

Taking the protein as an example, we can determine the proportion of it digested by dividing the 7.68 pounds by the weight of it given in the feed, 14.76 pounds, the result would be 52, the per cent of protein of clover hay digested by the steer. In the same way the per cents digested of the other constituents of the ration are found. This would be for crude fiber 47 per cent, for nitrogen-free extract 61 per cent, and for fat 48 per cent. Results thus obtained are called *digestion coefficients*. The digestion coefficient of the protein of clover hay is 52. The digestion coefficient of crude fiber in this experiment would be found in the same way to be 47, that of the nitrogen-free extract 61 and that of the fat 48.

The two steers are fed and treated exactly alike. If both animals are normal and healthy and no mistakes are made in the prosecution of the experiment, the digestion coefficients found by one steer should coincide very closely with those found by the other. Repeated experiments have shown that cows do not differ much as to the amounts of protein, carbohydrates and fat they can digest from the same material. The digestion coefficients found by one animal therefore will hold good approximately for all other animals of the same species. It is not true on the other hand, that the digestion coefficients of one fodder will apply to any other. For instance, while but 52 per cent of the protein of red clover is digestible by cows, 73 per cent of the protein of pasture grass was found digestible in Pennsylvania, while of timothy less than half the protein was found digestible at the Maine and Utah Experiment Stations. Of the protein of corn silage about 53 per cent is digestible. The protein of linseed meal is much more digestible, fully 87 per cent of it being

utilized by the cattle. The protein of wheat bran is also highly digestible, the digestion coefficient being 78.

An examination of the records shows that what is true of the protein in this respect applies with equal force to the carbohydrates and fat. While the carbohydrates of the grains and by-products are very largely digestible, a good deal of the starch and other carbohydrates of the rough forage is so encased in woody fiber as to escape the action of the digestive fluid in the intestinal canal. Because of this variation in digestibility among the forage crops and other cattle foods it has been found necessary to try digestion experiments with each of them. To insure accuracy, these experiments have been carried on with at least two animals at a time and in most cases have been repeated several times, the results being in the main concordant.

It is evident that in estimating the value of a given cattle food we ought to take into consideration the digestible part only. The share of the protein for instance that, under ordinary circumstances, passes through the cow undigested is of no value as far as she is concerned and should not be counted upon in calculating the amount of material she should receive in her daily ration. In comparing two fodders also it is not enough to know how much of the total nutrients each contains, we must know in addition the share that is digestible. Having determined the proportion of digestible protein, carbohydrates and fat in each of our fodders we will thereafter take account of those digestible parts only. For instance in the clover hay above but 52 per cent of the 12.3 per cent of protein was digestible, or 6.4 per cent. While there was 24.8 per cent of crude fiber in the clover hay but 47 per cent of it was digestible or 11.65 per cent of the clover hay was digestible crude fiber. Of the 38.1 per cent of nitrogen-free extract but 61 per cent was digestible, or 23.24 per cent of the clover hay was made up of digestible nitrogen-free extract. In the same way remembering that but 48 per cent of the fat was digestible we find that the clover hay contained 1.58 per cent of digestible fat. The digestible crude fiber and digestible nitrogen-free extract are of equal value and are combined for the digestible carbohydrates. The 11.65 per cent of digestible crude fiber added to the 23.24 per cent of nitrogen-free extract makes 34.89 per cent of digestible carbohydrates. Summing these results of the combination of the chemical analysis of clover hay and the digestion experiments we have the conclusion that clover hay contains 6.4 per cent of digestible protein, 34.89 per cent of digestible carbohydrates and 1.6 per cent of digestible fat.

COMPOSITION OF FEEDING STUFFS.

Chemical analyses have been made of all of our common feeding stuffs at the Experiment Stations in the different States. The average of a large number of analyses has eliminated the errors which might have been suspected had but one or two tests been made. With most of the feeding stuffs digestion experiments have been performed. In the following table these results have been brought together and the table sets forth the amount of dry matter, which the given fodders contain and in the succeeding columns the per cents of digestible protein, carbohydrates and fat.

TABLE I.—*Dry matter and digestible material in one pound.*

	Dry matter.	Protein.	Carbo-hydrates.	Fat.
Green fodder:	lbs.	lbs.	lbs.	lbs.
Corn fodder:				
Flint, cut early	.202	.0122	.1257	.00518
" after glazing	.229	.0128	.134	.0059
Dent, cut early	.21	.01173	.1238	.0083
" after glazing	.266	.0106	.1524	.007
Sweet	.209	.01159	.12156	.0087
Leaves and husks	.3046	.011	.1?07	.0087
Stripped stalks	.239	.00305	.15479	.0037
Sorghum	.1991	.0019	.123	.0037
" leaves	.2262	.0168	.1168	.006
" stalks	.2182	.0027	.1425	.0049
Kaffir corn	.2547	.0051	.1365	.0046
" " leaves	.288	.031	.1312	.0134
" " stalks	.2399	.0042	.1444	.002
Timothy before bloom	.384	.022	.23	.007
" after "	.41	.0139	.212	.00689
Orchard grass	.27	.0152	.1143	.0046
Millet	.25	.018	.118	.008
Green oats	.378	.027	.227	.01
Red clover	.292	.029	.141	.007
Alsike clover	.25	.027	.131	.006
Peas and oats	.16	.018	.071	.0024
Rape	.13	.02	.048	.004
Pasture grass	.2	.0?6	.106	.005
Cabbage	.097	.021	.058	.004
Pumpkins	.21	.004	.071	.001
Silage:				
Corn, immature	.1981	.0041	.1131	.0059
" mature	.21	.009	.1144	.0062
Sorghum	.239	.006	.149	.002
Kaffir corn	.2409	.0046	.1436	.0064
Pea	.4992	.0461	.2206	.0124
Red clover	.28	.02	.185	.01
Alfalfa	.859	.014	.204	.01
Hay and dry coarse fodder:				
Corn fodder	.578	.026	.333	.011
" stalks	.599	.02	.334	.006
Timothy, cut early	.85	.0293	.41	.0147
" " late	.859	.0244	.4288	.0108
Mixed hay	.84	.036	.427	.01
Orchard grass hay	.86	.049	.399	.014
Hungarian hay	.923	.045	.464	.01
Millet hay	.9135	.0408	.504	.01
Oat hay	.911	.042	.427	.015
Red clover hay	.847	.065	.349	.016
Alsike clover hay	.903	.068	.368	.014
Mammoth clover hay	.788	.057	.32	.019
Alfalfa hay	.916	.076	.378	.013
Pea vine hay	.864	.043	.323	.008
Peas in bloom	.833	.091	.331	.016
Wheat straw	.914	.008	.379	.005
Oat straw	.908	.016	.414	.007
Rye straw	.929	.008	.427	.004
Roots and tubers:				
Potatoes	.21	.0127	.1557	------
Table beets	.115	.009	.076	.001
Mangolds	.091	.0087	.061	.002
Sugar beets	.135	.011	.093	.001
Turnips	.095	.0063	.0668	.002
Ruta Bagas	.114	.009	.071	.002
Carrots	.114	.01	.071	.008
Artichokes	.20	.02	.168	.002

TABLE I.—*Continued.*

	Dry matter.	Protein.	Carbo-hydrates.	Fat.
Grain:	lbs.	lbs.	lbs.	lbs.
Corn:				
Dent	.894	.0713	.6308	.041
Flint	.887	.078	.645	.03
Sweet	.912	.0916	.6202	.0502
Barley	.891	.095	.661	.012
Oats	.89	.091	.447	.041
Rye	.884	.083	.655	.012
Wheat	.891	.092	.649	.014
Buckwheat	.874	.077	.492	.018
Millet seed	.86	.095	.45	.026
Sunflower seed	.92	.104	.246	.212
Beans	.678	.181	.3559	.016
Mill products:				
Corn meal	.864	.07	.66	.035
Corn and cob meal	.894	.046	.587	.031
Pea meal	.895	.18	.56	.009
Pea bran	.877	.056	.463	.02
Ground flax	.877	.172	.189	.352
Corn and oats, equal parts	.892	.0862	.549	.036
By-products:				
Linseed meal, old process	.908	.283	.328	.071
" " new "	.90	.307	.384	.027
Cotton seed meal	.918	.369	.181	.128
Buckwheat middlings	.873	.22	.334	.054
Gluten meal	.904	.288	.398	.12
" feed	.903	.183	.486	.097
Wheat bran, old process	.88	.101	.475	.026
" " " "	.908	.125	.412	.012
" " roller "	.88	.126	.441	.029
" " " "	.90	.1287	.406	.023
Rye bran	.884	.097	.48	.016
Wheat middlings	.879	.122	.472	.029
Rye middlings	.907	.119	.451	.016
Dried Brewers' Grains	.923	.162	.355	.053
Malt sprouts	.904	.196	.362	.017
Corn cobs	.893	.016	.439	.008
Apple pomace	.138	.01	.119	.011
Skimmed milk	.096	.031	.047	.008
Buttermilk	.099	.039	.04	.011
Whey	.066	.008	.047	.003
Apples	.152	.003	.128	.002

The table here given is compiled from various sources and represents the work of many experiment Stations. Some of the chemical analyses were made at this Station and are brought into this table by use of the American digestion coefficients found in Vol. VI of the Experiment Station Record, page 7. Others are taken from the table in Woll's Dairy Calendar, 1895, pages 260 e. s., which in turn were largely compiled from Jenkins and Winton's tables of Analyses of American Feeding Stuffs.

FEEDING STANDARDS.

It is evident that these tables, while giving for the different feeding stuffs the amounts of dry matter and of digestible protein, carbohydrates and fat, can be of but little use to the farmer who does not know how much of each of these materials a cow requires per day. These tables aid him by translating the various foods into terms common to all of them. A practical feeder has found that 35 pounds of silage, 10 pounds of clover

hay, and 10 pounds of wheat bran per day make a ration that keeps a thousand pound cow in good condition and allows a full flow of milk. A trial of this ration for a period of reasonable length, say for a whole winter, noting the results in the increase of live weight of the cow or in milk and butter yielded, is a valuable experiment. Other dairymen want to profit by the results of this experiment but one of them has silage and no clover hay, and another has clover hay but no silage. How can these cow feeders gain anything from the experience of the first dairyman?

Beginning in Germany and France a host of experiments were performed with dairy cows in full milk. All sorts of fodders and grain feeds were used. A record was kept of the amounts of each consumed, the resulting yields in milk and butter were recorded, the various foods were analyzed and digestion experiments performed with them. From the results of a multitude of such experiments performed partly by practical feeders and partly by the German experiment Stations, Dr. Emil Wolff, the Director of the Hohenhein Experiment Station, after careful study proposed a feeding standard for milk cows per day and thousand pounds live weight. Taking the average of a great number of experiments and practical feeding trials he found that the medium sized cows of Germany giving a satisfactory flow of milk, required sufficient food to furnish daily 24 pounds of dry matter; that in this dry matter there was two and one half pounds of digestible protein. He found farther that, with the ordinary feeding stuffs obtaining in Germany, 24 pounds of dry matter containing 2.5 pounds of protein would contain also 12.5 pounds of carbohydrates, and a little less than one half a pound of fat.

Prof. Wolff farther suggested as an observation justly warranted by the results of the many experiments whose records were before him, that to secure the best results, for every pound of protein in the ration there should be fed about five and four tenths pounds of non-nitrogenous material. It is believed that one pound of fat is equal in feeding value to two and one quarter pounds of digestible carbohydrates. In estimating the non-nitrogenous materials to compare with the protein, the fat of the ration is multiplied by two and one quarter and added to the digestible carbohydrates.

It is not necessary here to go into a discussion of the part played by protein in the nutrition of the cow. The transformations which take place in her body are still largely enveloped in mystery. It is a matter of experience, however, that where the cow receives less than two and one-half pounds of protein per day she cannot make her maximum yields. She has no creative ability, she can simply transform the materials of her food into flesh or fat or milk. The composition of the latter is fixed. For every pound of fat she secretes in her milk she must produce, with it, fully a pound of casein, a material practically identical in composition with the protein of her food. Again an uncertain, but not small amount of protein must be used up in the body to carry on the vital functions. The sum of these two demands, for the casein of the milk and for the support of life, it not less than two and one-half pounds for a cow of average size in normal condition and giving a fair flow of milk. These were the conclusions of Prof. Wolff.

In January 1894, a bulletin entitled "One Hundred American Rations for Dairy Cows", written by Prof. F. W. Woll, was issued by the Wiscon-

sin Experiment Station. In this bulletin the author compiles the feeding rations used in over a hundred dairies scattered from the Pacific to the Atlantic ocean. After a study of the results, he wrote as follows:—(Wis. Bulletin 38, page 46.)

"Combining all of the above 128 rations which have been fed by successful dairy farmers and breeders in the various parts of our continent we have the following average American ration, as it may be called, as against the rations published by German experimenters, and heretofore largely used in this country."

American standard ration for dairy cows.

	Dry matter.	Digestible matter.				Nutritive ratio.
		Protein.	Carbo-hydrates.	Fat.	tal.	
	lbs.	lbs.	lbs.	lbs.		
Average for 128 herds	24.31	2.15	13.27	.74	16.16	1:6.9

"This ration is practically the same as the one published in Bulletin 33 and in our 9th report; it is believed that it will be found correct for our American conditions, except perhaps for those of the Rocky Mountains and the Pacific States. While local conditions or the business methods of farming in some places may make a ration desirable which contains more protein than this and has a narrower nutritive ratio as a consequence, we feel confident that in the large majority of cases its adoption will give satisfactory results, and that it is preferable to the German standard ration so long placed before our stock feeders as the ideal one, the nutritive ratio of which is 1:5.4. It is the result of American feeding experience; the majority of our most successful dairymen feed in the way indicated by the ration and we shall not go far amiss if we follow their example."

Later in this bulletin some calculations will be given of the rations fed at this Station and the deductions that are warranted therefrom.

Knowing the composition of the feeding stuffs which he has on hand or which he can purchase, and knowing the amounts of dry matter and digestible protein, carbohydrates and fat they each contain, the dairyman is prepared to decide how much of the different materials his herd will require, which fodders he will feed, what he will sell and what he shall buy, since he knows the amounts of protein, and other nutrients his cows will require per day during the season and the amounts of the same which a given weight of each of his fodders will supply.

CALCULATION OF RATIONS.

A dairy herd is to be fed during the winter and there is on hand on the farm the following list of materials which are worth in the market the prices indicated. The dairyman can purchase in the local markets the feed stuffs given in the latter part of the table at the prices mentioned. The problem to be solved, as an illustration of the methods used in com-

puting rations, is to determine economical rations for the herd during the winter and incidentally whether any of the grain grown on the farm should be sold and the proceeds used to purchase commercial feeding stuffs.

FEEDING STUFFS GROWN ON THE FARM.

Clover hay at		$6 00 per ton.
Timothy hay at		8 00 per ton.
Silage at		2 50 per ton.
Shelled corn at	30c bu. or	10 70 per ton.
Oats at	22c bu. or	13 75 per ton.
Wheat at	90c bu. or	30 00 per ton.
Mangolds at		2 50 per ton.
Millet hay at		5 00 per ton.
Corn stalks at		3 00 per ton.
Oat straw at		2 00 per ton.

FEEDING STUFFS IN THE MARKET.

Linseed meal	$19 00 per ton.
Wheat bran	9 50 per ton.
Wheat middlings	10 50 per ton.
Gluten meal	17 00 per ton.
Buckwheat middlings	18 00 per ton.
Malt sprouts	15 00 per ton.
Cotton seed meal	20 00 per ton.
Pea meal	16 00 per ton.

In making the selection of the feed for his cattle the farmer will be controlled largely by the kind and quantity of coarse fodders he has on hand. Regardless of their cost, whether known or unknown, or assumed value in comparison with other feeds, these coarse fodders will form the bulk of his ration. His cows are to be used as machines for converting these products of the farm into butter. The dairyman will not consider in the first instance then, what ration he can compound that will best suit the cows from a physiological standpoint, that will make them give the largest yield of milk and butter, regardless of cost, but what ration will bring the largest net return for the forage upon his farm. In other words the dairy herd must be considered as an integral part of the general farm management and not as a separate institution whose best good is to be considered independent of the rest of the farm.

It is more than probable that the grain which the farm has produced will not fit to the best advantage into the coarse fodders to produce the best and cheapest ration. For the most part there is a ready market for this grain for cash and should it appear that some by-product, like bran or gluten meal, costing less in the market than the grain will bring, is really worth more pound for pound to supply some needed factor in the ration, he will sell part at least of the grain and buy with the proceeds some of the given by-products. In this way he will both better and cheapen his ration. The wheat, for instance, he will sell because its market price is greater than its value for cattle feed. It is more than possible that the same thing is true of part at least of his oats. Corn, on the other hand, is produced so abundantly in this country that it brings in the market a price relatively low, when its high content of nutrients is considered. The dairyman will therefore find himself seldom justified in selling corn.

It may be well at this point to compare the feeding stuffs on hand and that may be purchased as to their content of digestible nutrients and the cost of one pound of nutrients in each, at the prices assumed. Be it remembered, however, that this comparison is made with the prices assumed and that the cost of one pound of digestible nutrients here given is true alone when the prices of the different feeding materials are the same as those assumed. The method of determining the cost pei pound of digestible nutrients in these feeding stuffs is simple.

Let us take oats as an instance. By reference to table 1 we see that in one pound of oats there is .091 pounds of digestible protein, .447 pounds of digestible carbohydrates and .041 pounds of digestible fat. Adding together these amounts of protein, carbohydrates and fat, there is as a result .579 pounds of digestible nutrients in a pound of oats. Multiplying these amounts by 100 and setting them down in tabular form we have this table:

	Digestible protein.	Digestible carbo-hydrates.	Digestible fat.	Total digestible nutrients.	Cost of 1 pound digestible nutrients.
	lbs.	lbs.	lbs.	lbs.	
100 pounds oats	9.1	44.7	4.1	57.9	$0.0119
100 pounds bran	12.6	44.1	2.9	59.6	.008

The cost of one pound of digestible nutrients given in the last column of the table is found by dividing the value of the hundred pounds of oats, at the price assumed, $.6875, by 57.9.

In the same way the digestible nutrients and cost of one pound of digestible nutrients were calculated for bran.

Treating the other feeding stuffs in the same way we determine the cost of one pound of digestible nutrients in each.

TABLE II.

Material.	Price per ton.	Cost of one pound digestible nutrients.
Linseed meal	$19.00	$0.0139
Wheat bran	9.50	.0079
Wheat middlings	10.50	.0084
Gluten meal	17.00	.01
Buckwheat middlings	18.00	.015
Malt sprouts	15.00	.013
Cotton seed meal	20.00	.0148
Pea meal	16.00	.01
Oats	13.75	.0119
Corn meal	12.03	.0078
Clover hay	6.00	.007
Timothy hay	8.00	.0176
Silage	2.50	.0096
Mangolds	2.50	.0174
Millet hay	5.00	.0045
Cornstalks	3.00	.0041

Comparing first the coarse fodders we note that digestible nutrients cost over a cent and three quarters in timothy hay and but seven tenths of a cent per pound in clover hay. A reference to Table I shows farther

that the per cent of protein in the latter is twice as great as in the former. Protein is the element in which the home grown feeds are most apt to be lacking and the one that has to be purchased usually in the form of bran or some other by-product to complete an efficient ration. It is evident, therefore, at the outset of our study of this problem, that we can hardly afford to feed timothy hay if we have abundant supply of clover. In fact, if clover hay can be purchased, at the prices named, it would be better to sell the timothy and buy clover if the supply is short.

Corn stalks and millet hay furnish digestible nutrients at small cost, but these digestible nutrients so furnished are very low in protein, and call for the purchase of relatively large amounts of by-products to supply this element. Comparing silage and mangolds, both of which are succulent fodders, we find that the former is much the more economical. Since both are produced on the farm, and neither is a readily marketable commodity, both will be fed, and such a course is advisable, since it affords variety to the ration. When, in the spring, plans are being devised for growing food for the herd the ensuing winter, the relative cost of digestible nutrients in silage and mangolds will be borne in mind and the silage will be relied upon as the chief succulent feed, and only enough of the mangolds raised to furnish the desirable variety.

Among the grains and by-products, corn meal furnishes the essential food elements more cheaply than does any other. Next in the list comes wheat bran at .8 of a cent per pound, for digestible nutrients. It so happens that a combination of corn meal and bran fits into the most common mixtures of coarse fodders most perfectly and furnishes the desired grain ration at relatively low cost. In chemical composition oats and bran are similar, the latter being somewhat richer in protein and the former in fat. At the prices assumed, one pound of digestible nutrients in whole oats is worth \$.0119 and in bran but \$.008, or 32 per cent less. When, therefore, bran is worth \$9.50 per ton it furnishes digestible nutrients of approximately the same quality at the same price per pound that oats would furnish them if worth but fifteen cents per bushel. In other words, as far as chemical composition goes, oats at fifteen cents per bushel are of equal feeding value with bran at \$9.50 per ton.

Both gluten meal and pea meal are rich in protein, and are therefore feeding stuffs which the farmers will buy to mix with corn stalks, millet hay and other coarse feeds which are poor in protein; but gluten meal contains per hundred pounds, 28.8 pounds of protein, while pea meal has per hundred pounds but 18. Both furnish digestible nutrients, at the prices assumed, at one cent per pound. As far, therefore, as total digestible nutrients are concerned, if bran is worth \$9.50 per ton, both gluten meal and pea meal should be worth \$12.66 to furnish digestible nutrients at the same price per pound. In the same way, counting the cost per pound of total digestible nutrients and regarding in this view of the case a pound of protein, a pound of carbohydrates and a pound of fat of equal value, we could estimate the prices at which other grains and by-products must be sold to furnish digestible nutrients as cheaply as bran at \$9.50 per ton. In such a table, buck-

wheat middlings would be rated at $9.61 per ton, malt sprouts at $9.12, cotton seed meal at $10.63 and linseed meal, old process, at $10.78. These figures, however, would be entirely misleading as indicating the relative value of these different grain feeds for the use of the farmer. He can supply the carbohydrates and fat much more cheaply in the form of hay, corn stalks, silage and straw than he can purchase them in these expensive by-products.

A very little experience in calculating rations will emphasize the fact that protein is the one element which he will have to look for in the feeding stuffs he buys. A comparison of these by-products as to their content of protein and relative prices may give some light as to which furnishes protein most cheaply. If the price per ton be divided by the number of pounds of protein in a ton the result will be the cost of a pound of protein in the given material if the value of the other constituents be not regarded. At the prices assumed in this bulletin cotton seed meal would supply protein at $.027 per pound, gluten meal at $.0295, linseed meal at $.034, malt sprouts at $.038 and pea meal at $.044. These prices of the protein in the different materials do not give an accurate indication of the relative values of those materials as a whole, but will aid us in selecting the ones to purchase to go with our cheapest fodder, characteristically poor in protein.

Having at his command a lot of corn stalks, millet hay, clover hay and mangolds besides the silage he must choose between them the one which he will use for the basis of his ration. If sheep are kept and young stock of the cattle kind, he will naturally devote his silage to the milk cows and the bulk of the remaining coarse materials to the other stock. With the silage he will feed some kind of hay. Let us suppose that he should decide to feed thirty-five pounds of silage and ten pounds of clover hay per cow. Table 1 shows the amounts of dry matter and digestible nutrients in one pound of these materials. Multiplying these amounts of dry matter, protein carbohydrates and fat in one pound of silage by 35 and the amounts of dry matter and digestible nutrients in one pound of clover hay by ten, we have the amounts shown in the following table:

	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Cost.
	lbs.	lbs.	lbs.	lbs.	
35 pounds silage	7.35	.315	4.00	.217	$0.0438
10 pounds clover hay	8.47	.65	3.49	.16	.03
In both	15.82	.965	7.49	.377	$0.0738

As we have seen, the combined experience of practical feeders and the investigations of the Experiment Stations have shown that a cow needs not far from 24 pounds of dry matter per day if she is in the middle of her period of lactation, is of medium size and is giving an average flow of milk. In this dry matter there should be fully 2.2 pounds of protein and as much of the carbohydrates and fat as we can get the ration to encompass and the cow to eat, which will

not be far from 13 pounds of the former and from .75 to 1 pound of fat. The silage and clover hay together contain but 15.82 pounds of dry matter, the lacking 8.18 pounds must be derived from some other material. There is also a lack of 1.235 pounds of the protein. Of the grain feeds and by-products, wheat bran furnishes digestible nutrients at the smallest cost. Moreover, a reference to table 1 discloses the fact that while 10 pounds of bran will furnish more than the needed amount of dry matter, namely, 8.8 pounds, it will supply also the needed protein, 1.26 pounds. We can then make a new table, thus:

Ration 1.

	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Cost.
	lbs.	lbs.	lbs.	lbs.	
In silage and hay	15.82	.965	7.49	.377	$0.0738
Wheat bran, 10 pounds	8.8	1.26	4.41	.29	.0425
Total	24.62	2.225	11.90	.667	$0.1163

This ration, costing eleven and a half cents, or slightly more, per day per cow, contains enough both of dry matter and protein, but is somewhat deficient in carbohydrates.

To compare with this ration, let us make up one, using the corn and oats already on the farm, that we may know whether it is wise to sell any of this grain to buy bran. Using the silage and clover hay as before, let us first form a ration in which five pounds of a mixture of equal parts by weight of corn and oats ground together is substituted for five pounds of bran. The ration will then stand like this:

Ration 2.

	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Cost.
	lbs.	lbs.	lbs.	lbs.	
Silage and hay	15.82	.965	7.49	.377	$0.0738
Corn and oats, 5 pounds	4.46	.431	2.74	.18	.0344
Wheat bran, 5 pounds	4.40	.63	2.21	.14	.0213
Total	24.68	2.026	12.44	.702	$0.1295

In obtaining the cost of the corn and oats in this instance one eighth of the cost of the original grains is added for grinding.

This ration costs 1.32 cents per cow per day more than the former one. It does not necessarily follow, however, that it should not be used. The distance from market and from the mill would have to be considered. If the grinding can be done by a windmill or a cheap power on the farm it may pay better to use the corn and oats than to sell them and buy bran at the prices assumed. In the silage there

is, of course, considerable corn, and it would be expected that, for the sake of variety, it would be better to use grain other than corn to supplement the ration.

Examining Table II again it is noticed that millet hay furnishes digestible nutrients so cheaply that it is probable that it could be used to advantage in the ration with silage. Fifteen pounds per day would be a fair amount to try, the ration would then be:

Ration 3.

	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Cost.
	lbs.	lbs.	lbs.	lbs.	
30 pounds silage	6.30	.27	3.43	.186	$0.0375
15 pounds millet hay	13.70	.61	7.56	.015	.0375
	20.00	.88	10.99	.336	.075
6 pounds malt sprouts	5.42	1.18	2.17	.10	.045
Total	25.42	2.06	13.16	.436	$0.12

The silage and millet hay lack four pounds of dry matter and one and two tenths pounds of protein of conforming with the standard ration, as found below for the average sized cows of the College herd, and falls still farther below the German standard. Table I shows that six pounds of malt sprouts would furnish an ample amount of dry matter, and with it nearly enough protein to make the ration ideal. With the sprouts added the ration is as completed above and costs twelve cents per day per cow.

Remembering that gluten meal furnishes protein more cheaply than malt sprouts do, we might try five pounds of gluten meal instead of the malt sprouts. The 30 pounds of silage and 15 pounds of millet hay, with five pounds of gluten meal, would make a ration having 24.52 pounds of dry matter, 2.32 pounds of protein, 12.96 of carbohydrates and .93 of fat. Though the ration is more nearly perfect its cost is one quarter of a cent less per day.

Before deciding on the ration to be used, other combinations will be calculated in the same way with other feed stuffs to find out whether a cheaper and equally efficient ration cannot be compounded. The method of making these calculations has been sufficiently illustrated, and it will be enough to demonstrate the practicability of other combinations if the components are stated and the totals of the dry matter, protein, carbohydrates, fat and cost. Every reader of the bulletin, however, who keeps dairy cows should make an inventory of the fodders and grains he has on hand and of such materials as he can purchase in the market, should set down the market price of the latter and the selling price of the former, and with such data should compute several rations, adopting the one giving the greatest efficiency at least cost. Experience must teach the peculiarities of each feeding stuff. In the dairy literature he will find recorded the results of experiments with

nearly, if not quite every feeding stuff on the list. Of this information he should avail himself and should modify his adopted ration accordingly. It may be that his cheapest ration is not available because some one component is illy adapted to the production of milk for the purpose he wants it. When fed, the ration may produce too soft butter, or too hard, or it may be that while the calculated amount of dry matter, protein and other constituents, is theoretically correct, the combination is distasteful to the cow or does not keep her bowels in their normal condition. All of these factors must be considered and given due weight in practical dairy feeding. With all the information he can obtain from bulletins or other sources, and with all the experience obtained from feeding good and poor cows through many years, it is, after all, that indefinable something that we call judgment that determines the adaptability of the ration and the production of profit from feeding cows.

With the materials in our supposed case the following combinations are suggested:

Ration 5.

Forty pounds of silage, 10 pounds timothy hay, 5 pounds of pea meal, 4 pounds of gluten meal, this ration gives the results as under:

Dry matter	24.99 pounds.
Protein	2.29 pounds.
Carbohydrates	13 47 pounds.
Fat	.83 pounds.
Cost	$0.164

Ration 6.

If 15 pounds of clover hay be substituted in this ration for the 10 pounds of timothy hay and 4 pounds of gluten meal the results will be

Dry matter	25.58 pounds.
Protein	2.23 pounds.
Carbohydrates	12.66 pounds.
Fat	.523 pounds.
Cost	$0.135

A ration nearly as efficient and three cents per day cheaper.

Still other combinations, without silage as a basis, are suggested.

Ration 7.

Corn stalks, 8 pounds; clover hay, 10 pounds; corn meal, 4 pounds; wheat bran, 10 pounds, containing

Dry matter	25.52 pounds.
Protein	2.35 pounds.
Carbohydrates	13.22 pounds.
Fat	.63 pounds.
Cost	$0.1036

A ration rather high in dry matter, but very cheap and worth trying.

Ration 8.

Or, cornstalks, 10 pounds; clover hay, 8 pounds; corn meal, 4 pounds; wheat bran, 10 pounds, containing

Dry matter	25 02 pounds.
Protein	2.26 pounds.
Carbohydrates	13.23 pounds.
Fat	.61 pounds.
Cost	$0.10

As far as indicated by the chemical composition of the feeding stuffs and the mathematical calculations based thereon, the rations to be used with feeding stuffs at the prices named will be made up of clover hay, millet hay, silage, roots, cornstalks, corn meal, wheat bran and oats and gluten meal. The wheat and timothy hay would be sold, and of the feeding stuffs in the market wheat bran, gluten meal, malt sprouts, linseed meal, or cotton seed meal would be purchased, the choice depending on the amounts of the different coarse fodders on hand.

If the supply of clover hay was sufficient, bran would be the by-product to be bought, but if it is necessary to feed up a considerable quantity of cornstalks and millet hay, cotton seed meal, gluten meal or linseed meal in the order named would be chosen because they furnish the needed protein cheaply. Cotton seed meal cannot be fed in larger amounts than 2 pounds per day per cow, a fact to be remembered in calculating the amount of protein to be derived from it.

But rations cannot be built up on mathematical rules alone. The peculiarities of the different cows, the milk yield, the lapse of the period of lactation must all be considered. The rules and methods here given are but helps to the experienced feeder. They are not to take the place of judgment and experience, but to aid them. Cattle feeding cannot be relegated to the realm of applied mathematics nor can the tyro succeed as a cow feeder by studying chemical formulæ and rules of computing rations. Given, however, a thoughtful and experienced feeder, he can, by studying the composition of feeding materials, learn how to combine them to keep up the production of his herd at less cost and by reducing the cost, increase the profit.

THE M. A. C. STANDARD RATION, FOR DAIRY COWS.

The records of the feeding and milk yields of the dairy herd at the College may be studied in reference to the average amount of dry matter, protein, carbohydrates and fat consumed per thousand pound live weight per cow per day, and thus some light may be thrown on the question of a standard ration for dairy cows suitable to Michigan conditions. The College herd has been managed not differently from other herds in the State except that the feed has been weighed as has also been the milk yield. It must be remembered in considering these records that to obtain them, it has been necessary to weigh all the coarse fodder, all the grain, and in fact everything eaten by each cow, to set down the dates of the birth of the calf, the weights of the cow at weekly intervals, and the weights of each mess of milk and its

per cent of fat as shown by the Babcock test. This has involved an immense amount of labor, but it has been absolutely necessary, to make the results accurate and trustworthy.

The essential facts in the history of the cows, whose partial records are considered in the formulation of the College standard ration, are given in the following table. Since many of the cows were used in experiments which necessitated conditions modifying their yields or food consumption and since some cows calved in the spring and were nearly dry the following winter, but part of the total records at hand are available for the purposes of this discussion. It is important that the breed of the cow, the date of her birth and her yields of milk and fat in successive milking periods be set forth that a clear idea may be had of the general effect of the rations on the subsequent usefulness of the cow and that it may be farther shown that the cows were individuals of fully average merit.

TABLE III.—*Some College Cows and their Records.*

Name.	Breed.	Date of birth.	Yields of milk and fat.				
			Ending.	Length, months.	Milk, lbs.	Fat, lbs.	Butter, lbs.
Aida II	Guernsey	Jan. 12, '92	July, '95	10	3,155.9	157.94	184.26
			Sept., '96	10	6,043.8	340.65	397.42
			Aug., '97	10	5,049.6	251.87	293.84
College Pogis	Jersey	May 11, '90	Aug., '95	11	6.559.	316.26	368.97
			Oct., '96	11	11,314.71	553.06	645.23
			Aug., '97	4	4,565.9	207.91	242.56
College Pogis II	Jersey	Nov. 18, '92	Sept., '95	11	4,793.5	227.05	264.89
			Sept., '96	11	6,853.	352.36	411.08
			Aug., '97	10	6,306.4	330.96	386.14
Polly's Blossom	Guernsey	Aug. 21, '92	Nov., '95	11	5,231.7	244.66	285.43
			Mar., '96	3	1,875.1	82.52	96.27
College Dame LeBrocq	Jersey	Feb. 29, '92	Aug., '95	10	4,182.8	246.57	287.66
			Sept., '96	11	6,894.8	384.68	448.97
Cara	Red Polled	July 27, '93	Oct., '96	15	5,913.6	234.85	273.99
Oatka	Holstein	Mar. 26, '90	—— '92	----------	7,574.5	----------	----------
			Aug., '94	9	7,250.4	----------	----------
			Dec., '95	15	11,909.8	379.42	442.65
			April, '97	12	11,859.1	346.82	404.62
College Rosa Bonheur	Holstein	Feb. 6, '94	Aug., '97	12	14,171.9	453.79	529.42
Belle Sarcastic	Holstein	Jan. 18, '90	Nov., '95	19	30,514.2	915.94	1,068.60
			Aug., '97	18	29,544.77	941.31	1,098.19
Aaggie Wayne	Holstein	Nov. 10, '90	Oct., '93	----------	14,385.1	----------	----------
			Mar., '95	8	6,597.9	197.21	230.00
College Pauline Wayne	Holstein	Jan. 28, '92	Dec., '95	12	8,186.4	265.46	309.70
			Jan., '97	12	11,036.4	353.90	412.88
Houwtje D	Holstein	May 12, '88	Nov., '95	18	22,686.4	800.17	933.50
			Nov., '96	12	16,753.	570.81	665.94
Coll. Pauline America	Holstein	Oct. 31, '92	Jan., '96	14	8,216.4	258.75	301.87
			June, '97	12	7,195.0	206.04	240.40
College Houwtje	Holstein	April 18, '91	Dec., '94	----------	7,482.3	239.45	279.36
			Jan., '96	12	9,247.4	287.15	335.01

Victoria B. was a Shorthorn not belonging to the dairy herd, and her records for successive periods of lactation cannot for that reason be given. Jersey and Milla were grade cows, temporarily in the herd for use in an experiment. Their behavior was normal, however, and although their records cannot be given for the months preceding, a note was taken of their yields at the time the feeding recorded in the table below was made.

The Feed.—Silage formed the bulk of the ration. With the silage was fed a mixed hay composed of undetermined proportions of timothy and clover. Other coarse fodders, such as cornstalks, millet hay, alfalfa hay and small amounts of other fodders were occasionally used.

The grain ration has consisted of various mixtures of corn, oats, bran, linseed meal, cotton seed meal, gluten meal, and occasionally small amounts of other commercial grains and by-products. During the winter of '94-95 wheat was very cheap and limited quantities of it were fed. The main grain ration for that winter consisted of one half of a mixture of linseed meal, bran, oats and corn, in the proportion of one part of linseed meal to two of bran, three of oats, and four of corn, and one half of a mixture of bran and wheat, half and half. During the winter of '95-96 the usual grain ration consisted wholly of one part linseed meal, two of oats, three of bran and four of corn. In the winter of '96-97 the grain ration was made up of one part linseed meal, two parts corn, three of bran, and four of oats.

To give variety to the ration, roots were fed almost continuously during the winter months. These roots were for the most part mangolds, sometimes sugar beets or carrots.

The composition of the feeding stuffs being known, and the amounts fed daily having been carefully weighed, it was not difficult to determine the composition of the average daily ration of the various cows. The method of feeding differed somewhat from that generally used by experiment stations, but was the one adopted after considerable thought, and is one which is approved by farther experience.

The coarse fodders are weighed daily to each animal, the quantities given being gauged by the judgment of the feeder. Weights are taken on scales that read to half a pound. Variations of a less quantity in these cheap and relatively heavy fodders are not material. It was found, after trying the method for a year with the large herd, that to weigh the grain daily for each cow involved so many delicate weights and permitted so many errors that some other scheme had to be devised to insure accurate results. For the years 1895, 1896 and 1897, therefore, a box large enough to hold two hundred pounds of the grain mixture has been provided for each cow. Into this box there is weighed weekly enough grain to more than last a week. At the close of the week the box and the grain remaining in it are weighed and that weight subtracted from the weight of grain and box at the beginning of the week. In this way the amount of grain consumed by the cow during the week is accurately determined. This method is not applicable to experiments whose results depend upon a knowledge of the amount of grain consumed each particular day, but recommends itself to conditions where the record of food consumption for a long time is contemplated.

Analyses of the feeding materials were made by the chemical department of the Station not infrequently. To bring together many of these analyses the following table is given:

Composition of Michigan feeding stuffs, (original analyses).

No.		Dry matter.	Protein.	N. free extract.	Crude fiber.	Fat.	Ash.
1	Oat and pea silage	35.43	6.25	12.20	13.00	1.15	2.82
2	Lathyrus silage	21.06	5.31	6.59	6.47	1.04	1.65
3	Lathyrus in full bloom	19.94	5.58	7.34	5.25	.48	1.27
4	Millet silage	42.90	3.18	19.51	15.10	.73	4.38
5	Silage—Dec. 10, '95	31.38					
6	Jan. 13, '96	27.65					
7	Jan. 20, '96	22.32					
8	Feb. 4, '96	28.08					
9	Feb. 15, '96	21.74					
10	Feb. 25, '96	21.99					
11	Mar. 4, '96	20.49					
12	Mar. 17, '96	17.95					
13	Mar. 24, '96	20.37					
14	Dried pasture grass	36.05	8.14	14.81	7.94	1.68	3.48
15	Timothy hay	82.30	6.43	35.45	33.09	1.56	5.77
16	Common millet seed	85.72	13.96	53.54	11.08	4.39	2.75
17	Hungarian seed	80.91	15.75	50.15	8.20	3.87	2.94
18	Fodder corn—Aug. 24, '96	26.68	2.85	15.56	6.05	.72	1.46
19	Aug. 27, '96	23.57	2.08	14.29	5.42	.67	1.12
20	Aug. 31, '96	28.49	1.19	18.54	5.97	.91	1.12
21	Sept. 1, '96—very thick	30.75	.98	19.79	8.03	.54	1.71
22	Rows 14 inches	32.24	1.06	21.47	7.62	.65	1.39
23	Rows 28 inches	34.31	2.55	22.95	6.24	1.22	1.36
24	Rows 42 inches	30.06	2.01	19.57	6.25	.96	1.27
25	Rows 42x42	29.18	2.02	19.18	5.62	1.04	1.23
26	Sorghum—Sept. 2, '96	19.91	1.10	11.25	5.60	1.16	1.08
27	Corn—Sept. 16, '96	34.62	2.34	21.66	7.77	1.29	1.56
28	Silage—Dec. 1, '96—cut Sept. 16	25.31	2.13	13.73	6.84	.98	1.72
29	Cut Sept. 7	15.40	1.29	7.96	4.65	.56	.98
30	Cut Aug. 31	16.98	.68	10.73	4.11	.59	.87
31	Cut Aug. 27	21.74	1.03	12.69	6.00	.77	1.24
32	Kaffir corn—silage	24.09	.87	13.23	7.62	.79	1.57
33	Sorghum silage	19.97	1.36	10.27	6.74	.65	.97
34	Corn silage—Jan. 27, '97	22.31	1.83	12.81	5.86	1.84	.96
35	Beans	67.80	21.81	36.08	2.64	3.09	4.18
36	Fodder corn—Aug. 11, '97	17.31	2.23	8.62	4.76	.82	1.38
37	Aug. 27, '97	20.87	2.02	12.60	4.51	.56	1.18
38	Sept. 7, '97	27.49	2.75	17.61	5.00	.77	1.33
39	Sept. 15, '97	34.86	3.02	23.28	6.14	1.05	1.35
40	Sept. 22, '97—rows 7 inches	35.21	1.41	23.51	7.99	.57	1.72
41	Rows 14 inches	37.69	2.12	24.70	8.14	.79	2.07
42	Rows 42 inches	40.50	3.06	28.39	6.31	1.27	1.47
43	Salzer's fodder corn—Sept. 22, '97	30.62	2.41	20.17	5.82	.78	1.45

While the composition of the grain ration was fixed in the office of the Farm Department of the Experiment Station, the amount to be fed each day to each cow was left to the judgment of the expert herdsman. This plan was inevitable. No cow wants day after day the same amount of food nor even the same mixture. When the weather is cold and keen, her appetite is more vigorous, even if she is kept in a relatively warm but well ventilated barn, than on a warm and murky day. The proportion of coarse fodders to grain may profitably be increased on such occasions. The quantity, therefore, both of the coarse fodders

and of the grain feed and by-products was left entirely to the judgment of the man who fed the cows and who adjusted the quantity to the milk yield and the condition of the bowels.

It is interesting to note how nearly the daily ration thus prepared for a dairy herd by an expert feeder compares with the standard proposed in Germany or recommended by Prof. Woll.

In the tables that follow, there is recorded the average daily ration for several cows of the herd. The records of such cows only are used for this table as were not undergoing experiments which involved sudden or unusual changes of diet. The average daily ration is given for the month indicated. In nearly every case silage formed the basis of that ration. To obtain the daily ration for the month the amount of silage consumed during the month was divided by the number of days in the month. It would naturally be expected that a large cow would eat more than a small one, and it would hardly be fair to compare the work of different cows on the basis of the total amount of feed consumed per day. For that reason the table gives not the average amount of silage consumed per day, but the average amount of silage consumed per day *per thousand pounds live weight.* In the same way the amount of mangolds or hay or grain set down in the table is determined; first all that the cow ate of the given material in the month is found by adding together the amounts fed daily and the sum is divided by the number of days in the month and this quotient by the weight of the cow, expressed in thousand pounds or decimals of a thousand pounds, so that the amount set down in the table represents the average daily ration per thousand pounds live weight for the given month. Necessarily, the grain ration varied from month to month in composition and recalculation was necessary even when the grain ration for two succeeding months was identical in amount.

With both the amount and composition of each component of the ration known it was easy to calculate the dry matter, protein, carbohydrates and fat consumed daily.

There is, then, in the table, the actual amount of dry matter, of digestible protein, digestible carbohydrates and digestible fat in the average daily ration per thousand pounds live weight of the cows mentioned, but unless some indication was given of the efficiency of the ration, this data would not be sufficient to form a basis of an opinion as to its merits. The effect of the ration is measured by the amount of butter fat yielded daily and the changes in live weight. The amount of butter fat secreted by a cow varies greatly from month to month. It is almost invariably greater soon after the birth of her calf and gradually decreases as her milking period progresses. After the column giving the average daily fat yield for the month, the figure in the next column indicates the number of the particular month in the milking period. In the next column is given the average weight of the cow for the month.

To illustrate, the first name on the list of the smaller cows is Aida II. The first month for which her work is recorded is December, 1895. Her average daily ration *per thousand pounds live weight* for the month was 30 pounds of silage, 15 pounds of mangolds, 2 pounds of hay and 19

pounds of grain. In this ration there was 27.51 pounds of dry matter, 2.60 pounds of protein, 15.03 pounds of digestible carbohydrates and .96 pound digestible fat. The next column shows that her average daily yield of fat *per thousand pounds live weight* was 1.07 pounds. The next column shows that this month of December was the first month after the birth of her calf and therefore the first in this period of lactation, as it is called, and finally the last column shows the average weight of the cow for the month. The cows were weighed weekly and the amount stated is the average of the weekly weights. By comparing these weights for successive months it is possible to determine whether the cow was gaining or losing weight.

It is important to know in what part of the period of lactation the given month is, because the amount of feed eaten in proportion to the fat yielded is much less during the earlier months of the milking period than it is later and where the yields of several cows are to be compared this point must be noted.

DAILY RATIONS PER ONE THOUSAND POUNDS LIVE WEIGHT.

Smaller cows.

Months.	Silage.	Mangolds.	Hay.	Grain.	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Daily fat.	Month after calving.	Weight.
Aida II:	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.		lbs.
Dec., 1895	30	15	2	19	27.51	2.60	15.03	.96	1.07	1	865
Jan., 1896	38	15	2	18	29.31	2.56	15.42	.97	1.42	2	915
Feb., 1896	37	15	2	18	26.97	2.56	15.82	.95	1.42	3	936
Mar., 1896	31	15	1	18	24.50	2.46	14.21	.91	1.31	4	969
Apr., 1896	32	15	1	18	24.70	2.47	14.32	.92	1.33	5	977
Dec., 1896	31	15	4	14	24.08	2.21	13.04	.82	1.34	2	975
Jan., 1897	44.5	14.8	3	14	25.52	2.26	13.90	.88	1.23	3	1,007
Feb., 1897	44.5	14.8	2	13.96	24.72	2.23	13.49	.88	1.22	4	1,025
Mar., 1897	40	14.8	2	14.7	24.50	2.27	13.36	.88	1.09	5	1,063
College Pogis:											
Jan., 1895	16*	......	6	8	18.99	1.34	10.66	.38	1.18	4	954
Feb., 1895	24	......	6	8	17.17	1.25	9.63	.44	1.10	5	945
Mar., 1895	20†	......	6	8	18.43	1.95	12.48	.54	.95	6	956
Dec., 1895	31	11	2	18	25.25	2.19	14.79	.73	1.70	2	1,070
Jan., 1896	36	15	2	18	26.56	2.36	15.61	.77	1.82	3	1,086
Feb., 1896	36	15	2	18	26.56	2.36	15.61	.77	1.80	4	1,130
Mar., 1896	35	15	2	18	26.34	2.35	15.50	.76	1.80	5	1,150
Apr., 1896	35	15	1	18	25.50	2.31	15.08	.75	1.66	6	1,144
College Pogis II:											
Dec., 1895	37	17	2	21	31.65	2.71	17.54	.87	1.60	2	842
Jan., 1896	41	17	2.5	21	32.94	2.75	18.18	.94	1.60	3	880
Feb., 1896	33	15	2	18.4	26.28	2.36	15.46	.76	1.32	4	925
Mar., 1896	35	16	1	18.4	25.97	2.37	15.34	.77	1.26	5	910
Apr., 1896	34	16	2	17	25.44	2.26	14.93	.74	1.21	6	960
Dec., 1896	31	15	9	14	27.70	2.40	14.92	.87	1.63	1	975
Jan., 1897	44.5	14	3	13.6	25.17	2.21	13.70	.87	1.50	2	1,025
Feb., 1897	45	14.8	2	13.6	24.50	2.19	13.37	.86	1.30	3	1,025
Mar., 1897	45	15	2	11.5	22.66	1.95	12.39	.78	1.18	4	1,050
Polly's Blossom:											
Jan., 1896	37	14	3	12.5	24.36	1.96	10.51	.75	1.00	1	892
Feb., 1896	37	17	2.5	17	28.19	2.48	15.13	.92	1.13	2	840
Mar., 1896	33	17	2	20	27.72	2.75	16.00	1.00	1.17	3	876

Smaller cows—concluded.

Month.	Silage.	Mangolds.	Stalks.	Hay.	Grain.	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Daily fat.	Month after calving.	Weight.
College Dame Le Brocq:	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs	lbs.	lbs.	lbs.		lbs.
Dec., 1895	32	15	----	1	15.8	22.92	2.06	13.52	.68	1.14	4	1,027
Jan , 1896	36	15	----	2	12.7	23.70	1.82	12.63	.62	1.11	5	1,056
Feb., 1896	35	15	----	2	12.7	21.64	1 80	12.61	.62	1.11	6	1,086
Mar., 1896	34	15	----	1	11.8	19.35	1.62	11.34	.56	1.02	7	1,[illegible]
Apr., 1896	34	15	----	1	10	18.20	1.49	9.64	.53	1.11	8	1,130
Dec., 1896	31	14	----	6	12.3	25.16	1.98	13.83	.74	1.36	2	1,076
Jan., 1897	44	14	----	4	12.6	24.93	2.14	14.12	.82	1.00	3	1,154
Feb., 1897	45	15	----	2	11.2	22.32	1.86	12.73	.75	.70	4	1,190
Cara:												
Jan., 1897	32	15	----	3	12	22.72	1.87	12.07	.714	1.12	1	1,000
Feb., 1897	30	15	----	2	14	21.62	2.04	12.70	.77	1.70	2	990
Mar., 1897	30	17	----	2	14	21.82	2.06	12.83	.77	1.04	3	1,005
Apr., 1897	30	15	----	2	13	20.94	1.95	12.04	.73	1.07	4	1,013
College Dame Le Brocq:												
Jan , 1895	25*	------	----	6	8	22.82	1.50	12.67	.34	.75	4	864
Feb., 1895	24	------	----	6	8	19.40	1.32	9.73	.38	.80	5	855
Mar., 1895	20†	------	----	6	8	19.14	1.95	12.49	.51	.76	6	878
College Chemeaula:												
Feb., 1896	27	15	----	3	15	22.86	2.01	13.38	.64	1.10	1	1,066
Mar., 1896	28	15	----	1.8	18	24.30	2.27	14.40	.72	1.17	2	1,137
Jersey:												
Jan., 1896	------	14	12	5	10	17.54	1.45	10.28	.44	.91	6	800
Feb , 1896	------	8	9	5	9	15 31	1.26	8.85	.38	.92	7	775
Mar., 1896	------	7	2	8	10	16.76	1.39	9.55	.39	.89	8	750
Milla:												
Jan., 1896	------	18	11	6	13	21.14	1.82	12.56	.53	.90	2	945
Feb., 1896	------	8	11	6	11	18.45	1.52	10.67	.46	1.06	3	950
Mar., 1896	------	10	3	12	13	23.82	1.88	13.31	.52	.94	4	950
Average	29.82	12.85	1	3.29	14 12	23.57	2.06	12.50	.89	1.21		

* Millet silage.
† Oat and pea silage.

Cows nearly dry.

Month.	Silage.	Stalks.	Hay.	Grain.	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Daily fat.	Month after calving.	Weight.
College Houwtje:	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.		lbs.
Dec., 1896	27	10	------	6	14.95	1.02	7.72	.47	.4	8	1,457
Jan., 1897	33	8	------	7	15.20	1.17	8.62	.53	.4	9	1,484
Feb., 1897	33	7	------	6.3	14.32	1.08	8.12	.492	.34	10	1,479
Mar., 1897	33	9	------	6.5	15.00	1.12	8.50	.51	.4	11	1,512
Apr., 1897	33	3	2	6	14.68	1.08	8.09	.47	.4	12	1,509
College Pauline Wayne:											
Dec., 1896	36	8	------	8	18.51	1.31	9.49	.58	.36	11	1,402
Jan., 1897	36	12	------	9	20.45	1.47	10.61	.64	.28	12	1,458
College Pauline America:											
Dec., 1896	33	7	------	4	13.95	.83	6.93	.40	.2	7	1,494
Jan , 1897	33	8	------	5	15.10	.94	7.59	.44	------	8	1,523
Feb., 1897	33	7	------	8	15.8[illegible]	1.27	9.01	.53	------	9	1,565
Mar., 1897	33	6	------	4	12.04	.91	6.78	.39	------	10	1,599
Apr., 1897	30	------	2	5	12.37	.90	6.88	.40	------	11	------
Average	32.75	7.08	.33	6.23	15.20	1.09	8.20	.49	.28		

Larger cows.

Month.	Silage.	Mangolds.	Stalks.	Hay.	Grain.	Dry matter	Protein.	Carbo-hydrates.	Fat.	Daily fat.	Month after calving.	Weight.
Oatka:	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.		lbs.
Jan., 1895	33	------	----	3	10	19.95	1.42	10.46	.53	1.06	4	1,200
Feb., 1895	33	------	----	3	10	19.95	1.42	10.46	.53	1.09	5	1,200
Mar., 1895	33	------	----	3	10	19.95	1.42	10.46	.53	.90	6	1,300
Apr., 1896	34	29	----	.5	19	27.05	2.41	16.13	.79	1.30	1	1,188
Dec., 1896	26	------	7	------	7	14.77	1.09	7.66	.456	.66	9	1,269
Jan., 1897	38	------	9	------	8	19.90	1.33	9.86	.66	.53	10	1,374
Feb., 1897	38	------	7	------	7	18.49	1.20	9.04	.611	.3	11	1,237
College Rosa Bonheur:												
Dec., 1896	28.7	18	----	4.2	11.9	21.67	1.95	11.82	.72	.98	4	1,364
Jan., 1897	33.5	12	----	1.6	11.3	20.46	1.82	11.17	.71	.96	5	1,478
Feb., 1897	40	20	----	1.3	11.0	21.09	1.86	11.62	.73	.98	6	1,491
Mar., 1897	40	18	----	1.3	11.2	21.09	1.86	11.62	.74	.95	7	1,539
Belle Sarcastic:												
Jan., 1895	23.80	25.3	----	1	12.70	21.41	1.95	12.00	.61	1.13	10	1,540
Feb., 1895	24.68	18.4	----	1	11.58	23.00	2.00	12.80	.63	1.04	11	------
Mar., 1895	25.00	27.6	----	4	12.32	24.00	2.30	12.82	.69	1.00	12	------
Apr., 1895	25.50	32.0	----	3	10.20	24.26	1.90	10.50	.57	.98	13	1,600
Mar., 1896	22.6	25.2	----	2	14.10	20.85	2.05	12.16	.74	1.42	1	1,369
Apr., 1896	27.6	39.5	----	.6	15.30	28.37	2.32	13.78	.837	1.37	2	1,458
Dec., 1896	30	20	----	5	13.33	24.4	2.19	13.28	.80	1.08	10	1,463
Jan., 1897	38.7	20	----	5	13.33	26.2	2.27	14.27	.86	1.04	11	1,500
Feb., 1897	40	20	----	4	12.00	23.8	2.05	13.01	.79	1.01	12	1,520
Mar., 1897	38.7	19	----	3	12.40	23.73	2.05	12.63	.79	.97	13	1,530
Aaggie Wayne:												
Jan., 1895	26	------	----	6	8	19.48	1.31	9.73	.40	.56	6	1,266
Feb., 1895	33	------	---	5	8	20.80	1.73	11.50	.42	.64	7	1,284
Mar., 1895	25*	------	----	7	8	25.46	2.21	14.15	.48	.61	8	1,290
College Victoria B.:												
Jan., 1896	33	13	----	1.5	19	17.70	1.40	10.23	.503	.84	3	1,220
Feb., 1896	33	13	----	1.5	9	17.70	1.40	10.23	.503	.76	4	1,270
Mar., 1896	30	13	----	1	11	17.51	1.54	10.30	.515	.71	5	1,300
College Pauline Wayne:												
Mar., 1896	33	20	----	2	19	27.28	2.48	16.10	.79	1.38	2	1,166
Apr., 1896	28	25	----	1	19	25.43	2.43	15.20	.76	1.50	3	1,203
Mar., 1897	31	------	----	2	14	20.39	1.92	11.65	.74	1.08	1	1,298
Apr., 1897	38	------	----	2	18	21.07	1.67	11.93	.75	1.08	2	1,314
Houwtje D.:												
Jan., 1895	--------	------	----	------	--------	21.90	2.14	12.97	.62	1.00	9	1,600
Feb., 1895	--------	------	----	------	--------	21.44	1.70	11.03	.53	.90	10	------
Mar., 1895	45.6†	41.2	----	3.4	14	21.44	1.70	11.03	.53	.90	11	------
Apr., 1895	--------	------	----	------	--------	19.56	1.56	10.81	.50	.77	12	------
Dec., 1895	33.75	13	----	2.6	13.33	22.21	2.01	14.39	.80	1.35	1	1,448
Jan., 1896	40.3	28.2	----	2.8	15.73	27.24	2.48	15.70	.93	1.41	2	1,543
Feb., 1896	40.2	34.9	----	2.2	14.80	26.40	2.41	15.37	.90	1.31	3	1,601
Mar., 1896	36	33	----	1.3	12.90	22.98	2.09	13.37	.79	1.28	4	1,624
Apr., 1896	34	34	----	.5	12.10	21.17	1.97	12.41	.74	1.25	5	1,662
Jan., 1897	47	20	----	5.5	12.53	27.25	2.25	14.80	.876	1.42	2	1,512
Feb., 1897	40	18	----	3	10.00	21.40	1.79	11.70	.75	1.50	3	1,500
Mar., 1897	50	18	----	2.5	12.50	25.39	2.15	13.88	.86	1.23	4	1,558
Average	34 75	18.41	.5	2.5	12.15	22 11	1.89	12.23	.67	1.027	----	------

* Ration for the four months.
† Oat and pea silage.

There is given in the table the records of fifty-two separate months for the cows weighing about a thousand pounds, and forty-three months for the larger cows. Environed as these records are by every precaution to secure accuracy and fullness of detail, the net result, the general average, is here presented as a standard ration for Michigan conditions.

M. A. C. standard rations.

	Dry matter.	Digestible protein.	Digestible Carbo-hydrates.	Digest-ible fat.	Daily fat.	Average month.	Average weight.
	lbs.	lbs.	lbs.	lbs.	lbs.		lbs.
1,000-pound cows	23.57	2.06	12.50	.89	1.21	3.8	982.8
1,400-pound cows	22.11	1.89	12.23	.67	1.027	6.	1,396.68
Dry cows	15.20	1.09	8.20	.49	.23	9.8	1,373.5

The nutritive ratio of the standard ration suggested for the thousand pound cows is 1 : 7.1, that of the larger cows 1 : 7.21, and that of the cows in the very latest months of the period of lactation is much wider, being 1 : 8.53.

The tables from which these feeding standards were derived, page 90, conclusively demonstrate the limitations of the use of the feeding standards. They show that it is entirely wrong to assume as Wolff does to set up a stated amount of dry matter and of protein as correct for a cow of a given weight, or to graduate the amount of dry matter and of protein, which a cow should receive, by her live weight alone. One cow has a greater capacity to consume, digest, assimilate, and economically utilize food than another of the same weight. Again, the same cow requires a different amount of dry matter at one time than at another. In the early months of the period of lactation, when her yield is at the maximum, she requires a much larger amount of feed than later, when the draft upon her body for milk constituents, is lessened by the smaller yield. Take the case of Aida II, for instance. In January, 1896, although weighing but 915 pounds, her daily yield of fat was 1.42 pounds. Her average daily ration for the month supplied 29.31 pounds of dry matter per thousand pounds live weight, containing 2.56 pounds of protein, 15.42 pounds of carbohydrates, and .97 pounds of fat, with a nutritive ratio of 1 : 6.9. On this ration the cow continued her maximum yield through the month, and at the same time made a gradual gain in weight. The watchful eye of the feeder noted this fact, and slightly reduced the amount of dry matter in the ration. This was accomplished without changing the weight of the materials fed, but by feeding silage with a much lower per cent of dry matter. The dry matter fed per day to the cow was kept considerably above the standard to warrant the large yield of fat, during the five early months of the period of lactation.

Standing by her side was a mature Jersey cow, College Pogis, that had a tendency to lay on fat. She was giving a large flow of milk and was in January, 1895, in the fourth month of her milking period. Her ration was below the standard recommended. Her weight remained practically constant and her yield of fat gradually declined, as was to be expected from the lapse of the period of lactation. During the next winter her flow of milk and yield of fat daily was promising at the outset, and she was given 25 to 26.5 pounds of dry matter per day, with 2.36 pounds of protein. Her daily yield of fat kept constant for the three months of winter at 1.8 pounds or slightly more than 2 pounds of butter per day. The grain ration was kept up during the summer,

and by October the cow had made the phenomenal yields of 11,314.71 pounds of milk and 553.06 pounds of fat. It would have been sheer folly to measure her feed during the early months of her period of lactation by any standard based upon live weight alone or derived from the average feeding of average cows.

Still more remarkable is the consumption of dry matter and protein of College Pogis II during the winter of 1895-96. Here we have a cow that weighed in January but 880 pounds, who was gaining in live weight because still young and who was turning out regularly nearly 2 pounds of butter a day. She required on the average for a whole month over 32 pounds of dry matter *per thousand pounds of live weight* per day, containing 2.75 pounds of protein. The cow weighed but 880 pounds, and this 880 pounds was made up largely of digestive organs, lungs and udder. In proportion to her live weight she could consume and economically utilize a very much larger amount of feed than could an animal with a massive frame and relatively small per cent of viscera and udder.

A study of the tables shows conclusively that an expert feeder varies the size of the ration, not according to the weight of the cow alone or primarily, but according to her capacity to receive and her ability to yield, and that, with the same cow, the ration is modified as the period of lactation advances, to conform to the requirements of the system.

What is true of the dry matter is true of the digestible protein. Where a cow is secreting a large amount of milk containing from one to as high as two and one half pounds of dry casein per day, her food must be relatively much richer in protein than when she has not this demand upon her system to supply. The food requirements of the system to sustain the vital functions remain comparatively constant. To these requirements is superadded, in the periods of greatest milk yields, the demand for the butter and cheese in the milk. Protein is required not only to supply the casein of the milk, but to insure that active vitality of the whole nervous system which is involved in butter production. A farther discussion of the subject is not necessary to properly emphasize the fact that not only must a larger, but a richer ration as well, be given to a cow when giving a large yield than when comparatively dry.

As to the digestible fat, economic considerations demand that such a combination of foods be made, to furnish the requisite dry matter and protein, as will furnish at the same time fully .89 pounds of digestible fat per day for the smaller cows. But no definite amount of fat can be prescribed in the ration, first, because the word fat in this connection includes within its meaning many dissimilar substances. A pound of digestible fat derived from silage or green fodder is a very different thing from a pound of digestible fat derived from linseed meal or any of the by-products. Again, using the feeding stuffs grown upon the farm for the largest practicable share of the ration it would be difficult to propose an economical combination that would not furnish more digestible fat than the standard of either Wolff or Woll calls for.

It is evident from a consideration of all the facts in the case, that a standard ration cannot be used as a fixed rule in determining the

amount or kind of feeding stuffs that should be given a certain cow at a certain time. It can supplement and partially guide the judgment of the feeder, but it cannot take the place of judgment. Up to the present time no advice seems better supported by experimental evidence and more to the point than that of Prof. Julius Kühn in his article on "Feeding Standards for Domestic Animals" on page 11, Vol. 4, Experiment Station Record. He says: "For milch cows it is advisable first of all to determine the quantity of nutrients which represents the minimum requirements per thousand pounds live weight of the animals; that is, the quantity which covers the needs of the cows which are dry or nearly dry, and which while producing little or no milk are usually more or less advanced with calf. This minimum amount may be designated as the *basal ration*. It will naturally be more liberal for breeds of high productive capacity and those which keep up their milk yield well in the latter part of the lactation period and only go dry a short time, than for those of inferior milking qualities. For the latter the basal ration need not contain more than 1.5 to 1.7 pounds of digestible albuminoids, while with the former up to 1.8 pounds, and, with breeds of exceptionally high capacity even more will be needed."

A sufficient number of records are not submitted in the third division of the table, which gives the food consumption of the cows nearly dry, to warrant the statement of a definite conclusion. In each case there is a very evident increase in live weight, as there should be, when cows are approaching parturition. It is significant that the amount of digestible carbohydrates suggested by our cows does not vary greatly from the requirements suggested by Kühn in a part of the article following the section quoted, while the digestible protein is very markedly less in the case of the Michigan cows. The fact that our cows gained regularly in live weight is good, but perhaps insufficient evidence that the ration here suggested is a sufficient basal ration to be used as Kühn suggests, as representing the amounts of dry matter and digestible nutrients required by the cow to sustain the vital functions.

Whenever the ration is to be calculated for a growing cow in the flush of the early months of the milking period, the feeder will fix in his mind the proper standard ration having regard to the feeding capacity of the cow, her past history, the quantity of milk and fat she is secreting, and finally her size.

While the reason may not be altogether clear, the work of the cows points to the strong probability that a less amount of dry matter should be fed larger cows per thousand pounds live weight than smaller ones. This fact cannot be adduced from the feeding standard suggested above and the facts submitted to sustain it, because, while the 1400 pound cows require but 22.11 pounds of dry matter and the 1000 pound cows 23.57, the former were on the average in the sixth month of the milking period while the latter were at the beginning of the fourth. Between the fourth and sixth months a considerable fall in the milk production might be expected, and a corresponding decrease in the food supply would take place. This decrease in the food supply by reason of the fall in yield would at least partly account for the lower weight of dry matter and digestible nutrients reported by the 1400 pound cows.

To quote again from Kühn's article: "To feed an animal highly during the most productive part of lactation pays well, but to feed the entire herd equally well, without regard to individual production, can prove remunerative only when in addition to yielding milk the cows are to be fattened. Otherwise such feeding results in a great waste of food, is not infrequently the cause of the low profits in dairying and makes the barn yard manure expensive."

Recognizing the just limitations of the application of the feeding standard the daily ration of 23.57 pounds of dry matter 2.06 pounds of digestible protein 12.50 pounds of digestible carbohydrates and .89 pounds of digestible fat is suggested by the College herd, for cows in the third and fourth month of the period of lactation giving a good full yield of milk and butter. A knowledge of the feeding standard and the methods of computing rations is by no means all that there is of skillful cow feeding. That art is one which cannot be acquired without long experience in the stable, and one which involves the exercise of well trained powers of observation and, above all, well ripened judgment.

It is evident that the standard ration takes no cognizance of the relative money values of the various feeding stuffs. The practical feeder has to approach the question of what shall constitute his ration very largely from that side. He considers primarily not what combinations of food will cause his herd to yield the most butter, but what combinations he can bring together most economically, and by what combinations his cows will return the most net profit from the materials which his farm produces. This fact has been sufficiently illustrated in the preceding section of the bulletin relating to the computation of rations.

The standard ration fails to recognize the peculiarities of different feeding stuffs in the matter of their specific effects upon the quality of the butter produced or upon the health and condition of the cow. Some fodders, though showing a very high content of digestible nutrients, are nearly worthless because cows do not like them or because they seriously impair the quality of the products. It is not enough, therefore, to report the relation between the quantity of butter produced and the quantity of food consumed, when new forage plants are under discussion, the quality of the products and the relation of the material to the appetite of the cow must also be given, to round out and complete the proper history of the experiment. A discussion of some of the peculiarities of a few of the feeding stuffs used at the Station therefore naturally follows:

DISCUSSION OF FEEDING STUFFS.

Silage.—In keeping a record of the consumption of dry matter per day per cow the most troublesome factor has been the silage. On page 88 it is shown that, in the winter of 1895-96, the silage at the top of the silo contained much less water than that at the bottom, and that the per cent of dry matter varied continually. It is hard, therefore, to construct a table of fodder analyses that will fairly represent the composition of a given sample of silage at a given time on account of this great variability of the moisture content. The average per cent of dry matter in the nine samples analyzed in the early months of 1896 was 23.33. Where the silage was cut before the corn was fully mature and put in small silos the per cent of dry matter was very low as shown by the samples taken December 1, 1896.

Corn silage was used as the basis of the ration for the three years in which the complete dairy records have been kept. The butter made from the milk of the silage fed cows was of excellent quality, of the right consistency and body and free from any unpleasant flavors that could be traced to the silage. This was true although no special pains were taken to ventilate the barn prior to milking.

The cows were universally fond of the silage, and would eat it to the full amount allowed. Very little, if any, refuse was left in the mangers, the whole corn plant seeming to be consumed. No experiments have been undertaken at this Station to determine the relative values of field cured corn fodder and silage. That matter has, however, been so thoroughly studied in other states that conclusions seem to be well established. It has been found by a series of accurate experiments that the dry matter of silage is slightly more digestible than that of field cured corn fodder; that the losses in the silo are less than in field cured fodder when treated in the usual way; that an acre of corn will produce slightly more butter when stored in the silo than when field cured, and finally that an acre of corn can be put in the silo for approximately the expense involved in handling by the older methods. Our long experience demonstrates the practical value of the silo.

Early Amber Sorghum.—For the past few years this station has joined with those in other states in the investigation of new forage crops which it was hoped might take the place of corn or supplement it. Among these new forage crops sorghum and Kaffir corn have been urged upon the public. In 1896 a plot of a half acre was planted to sorghum for comparison with Kaffir corn and "Salzer's Superior Fodder Corn." The seed was planted in hills 18 inches apart in rows three feet apart, on the 5th of May. The soil was a sandy loam, heavily manured the fall previous. The plot was cultivated with a Breed's weeder May 14th, and frequently later during the season with a two horse cultivator. Although germination was much retarded by a cold, wet spring the sorghum grew rapidly during the summer and was, as far as could be judged by persons inexperienced in growing the crop, ready for harvest by September 1st. On that date the plot was cut, samples taken for analysis, and the entire yield put in the silo.

On the same day the adjoining plot of Salzer's fodder corn, which had been planted in hills 18 inches apart, in rows three feet apart, May 7th, and cultivated on the same dates and in the same manner as the sorghum, was also harvested and put in the silo.

The analyses of the sorghum and of the Salzer's improved fodder corn are given as numbers 21 and 27 in the table on page 88. The yields per acre of the two plots are given in the following table:

	Sorghum.	Silage corn.
	lbs.	lbs.
Green fodder	38,676.	29,684.
Dry matter	7,700.39	8,655.85
Protein	425.43	736.16
N. free extract	4,254.86	5,734.95
Crude fiber	2,169.72	1,733.54
Fat	448.64	311.68

As far as the yield per acre is concerned, the sorghum excelled the silage corn in total green fodder, but when the water was driven out, the yield of dry matter per acre was much greater in silage corn. The yield of protein by the silage corn was 310.73 pounds per acre more than was produced by the sorghum, a difference of 73 per cent.

It is only in the crude fiber and in the fat, which includes a large amount of the green matter of the leaves, that the sorghum excels the silage corn.

The silage was fed toward the spring of 1897, and the significance of the chemical analysis was shown by the cattle. While the silage from the corn was eaten up clean, that from the sorghum was picked over and the woody stems rejected. The total weight of sorghum silage did not shrink in the silo in gross weight in any greater proportion than did the corn silage, and, as is shown by a comparison of analyses 27 and 34, on page 88, the chemical composition of either sorghum or fodder corn was but little changed by keeping in the silo.

The silage was fed to the general herd in January, 1897. The five cows, Houwtje D, Aida II, College Pogis II, College Rosa Bonheur, and Belle Sarcastic, yielded for the week ending January 13th, 39.18 pounds of butter fat; for the week ending January 20th, when they were fed on the sorghum silage, 39.06 pounds of fat; for the week ending January 27th, when they were fed on fodder corn silage, 40.15 pounds of fat, and for the next three weeks, when fed on corn silage, the grain ration being constant throughout, 39.24 lbs., 37.88 lbs. and 37.74 lbs. As far as was observed the cows ate the sorghum silage with as much avidity as the corn silage, except that they rejected the woody stems.

Sorghum fodder grown in another field was shredded and fed. No careful experiments were conducted on the point, but it was noticed that the cows rejected a larger proportion of the stems of the sorghum, notwithstanding its content of sugar, than they did of the shredded corn fodder fed at about the same time.

Sorghum shows at no point, superiority to corn as a forage crop. On the other hand, its low yield of protein and its harsh, woody stems go far

toward condemning it as a substitute. Our experiments do not warrant us in recommending the crop in any locality where Indian corn can be grown. An acre of the latter will produce nearly as much protein as an acre and three-quarters of the former, and will at the same time yield fully twelve per cent more starch, sugar and other soluble carbohydrates. More extended feeding experiments must be conducted before the relative feeding values of these two forage crops can be fully determined, but as far as the trials already conducted at this station go, they show that a larger proportion of the corn plant is eaten than of the sorghum, and this whether fed in the form of silage or shredded fodder. Whether the plan of cutting sorghum while the plants are young and recutting frequently the suckers that are thrown out, is a good one or not remains for future experiments. Trials elsewhere show the practice of pasturing sorghum fields after the first crop is cut to be attended with danger.

Kaffir Corn.—This plant is a sorghum, but one that does not produce a sufficient amount of sugar in its juice to make it valuable as a source of molasses or sugar. It is therefore called a non-saccharine sorghum. While growing in the field it resembles corn. The ears at the side of the stalk are wanting, however, as it bears its seeds at the top.

A half acre of ground adjacent to the half acre plots of sorghum and Salzer's fodder corn was planted to Kaffir corn May 5th, 1896. The rows were three feet apart and the hills 18 inches apart in the row. It was cultivated first with a Breed's weeder and afterwards with the horse cultivators, at the same time and in the same way as the sorghum. The crop was harvested into the silo early in September, the gross yield per acre being 34,360 lbs.

An analysis of the green fodder was not made; that of the silage is reported as number 33 in the table, page 88.

The cows ate both the silage and the dry fodder of Kaffir corn with considerable relish. The main objection to the plant seems to be its stiff, woody, pole-like stems, which the cows will eat, neither when put in the silo nor when fed as dry fodder. It is slow to start in the spring, makes a tall growth and yields an abundance of green forage to the acre. As the analysis of the silage indicates, this growth is watery and much less valuable, pound for pound, than the same weight of corn. While the feeding tests made at this station have led to no positive results, they show negatively that Kaffir corn has so far shown no right to be reckoned as of equal value with corn as a forage crop for Michigan.

Clover Hay.—It has been impossible, in recent years, to obtain on the college farm until the season of 1897 a pure clover hay. Heretofore the nearest approach to it has been a mixture of timothy and clover. The root borer has not been as destructive during the fall of 1896 and the spring of 1897 as for the three years preceding, and full crops of clover hay are again possible.

This forage crop has proven valuable, first, because it is relatively rich in protein and digestible nutrients, and secondly, because it derives a large proportion of the fertilizers necessary to its growth from the air.

It would be out of place in this bulletin to go into a discussion of the utilization of the free nitrogen of the air by leguminous crops in general, and by clover in particular. For the purposes of this discussion it is

enough to remember that while a clover crop does exhaust to some extent the mineral constituents of the soil, still as a net result of the production of a crop of clover hay, a field is actually enriched in nitrogen.

This fact was clearly shown by an experiment performed at the station in the summer of 1897. A sandy knoll was bearing a heavy crop of clover. A section of earth four feet long by two feet wide in the clover plot was dug about and left standing, the earth on all four sides being removed to a depth of four feet. By means of iron rods thrust through the mass of earth from a strong board at each end and cross rods extending from side to side, the clover roots were held in place while the sand was washed away. Many of the finer roots were washed away with the sand. After removing the mass of tops and roots from the place in which they grew, it was photographed and separated into two parts by cutting the clover an inch above the crown, thus removing with the tops more than would be removed in the crop of hay. The experiment was performed July 2nd, while the clover was in full bloom.

The green tops weighed 2.44 lbs., and the roots 2.14 lbs. The dry matter in the tops weighed .99 lbs. and in the roots .656 lbs. A chemical analysis of the tops and roots showed the following composition of the dry matter:

Composition of clover forage and roots.

	Tops. Per cent.	Roots. Per cent.
Nitrogen	2.48	2.55
Potash	1.82	1.21
Phosphoric acid	.68	.89

Reducing these figures to the amounts of these fertilizing elements in the tops and roots on an acre, the results can be better appreciated.

Fertilizing constituents in the tops and roots of an acre of clover in full bloom.

	Tops.	Roots.
	lbs.	lbs.
Nitrogen	132.31	62.07
Potash	96.92	46.51
Phosphoric acid	36.26	31.90

In Bulletin 9, of the Mass. (Hatch) Experiment Station, analyses of six samples of barn yard manure are reported. Using the average of these analyses as fairly representing the composition of average barn yard manure, it is possible to estimate how many tons of manure it would take to supply to the soil the amount of nitrogen left in it by the roots of a heavy crop of clover. According to the figures obtained from the bulletin referred to, barn yard manure contains .289 per cent of phosphoric acid, .582 per cent of potash and .441 per cent of nitrogen. To supply the amounts of these elements left in the soil in the roots of the

crop of clover it would require 7 tons of manure per acre to furnish the 62.07 pounds of nitrogen, four tons to supply the 46.51 pounds of potash and five and one-half tons to supply the 31.90 pounds of phosphoric acid. A large share of the nitrogen in the roots of the clover is a direct gift of the crop to the soil, since it is taken from the air. The same is not true of the mineral elements, the potash and the phosphoric acid. These materials are derived by the clover roots from the soil; they get them, however, partly, at least, from strata of the soil below the reach of the shallow-rooted cereals and by their decay leave them where the subsequent crops can reach them. By adding to the store of nitrogen, by loosening compact soils by means of their deeply penetrating roots, and by bringing closer to the surface mineral matters which are far toward escaping from the roots of the cereals, the clover crop aids in restoring fertility to the soil.

These facts are true, notwithstanding the fact that the hay carries away with it a hundred and thirty-two pounds of nitrogen, nearly 100 pounds of potash, and over a third of a hundred pounds of phosphoric acid per acre. If the hay is fed on the farm this fact is immaterial, since these manurial elements will be returned with but slight reduction in the resulting manure; but, if it is proposed to sell the clover hay, this richness in the essential elements must be remembered.

The palatability of clover hay is greatly injured by rain at the time of haying. Clover is very succulent and dries slowly. If, when partly cured, it is wet by rain, part of its soluble constituents are removed. To dry it, the hay has to be turned, or, perhaps, shaken up by a tedder. This operation shakes off part of the leaves, and if repeated many times the feeding value of the clover hay is greatly reduced. An attempt has been made to avoid this loss by storing the clover in the silo, as fast as cut by the mower. Early in July, 1897, a small experimental silo, ten feet deep and six feet in diameter, was filled with green clover. It held 2,773 pounds. It was opened in September, when it was found that the silage had kept most excellently and had shrunk in weight to 2,587 pounds. The cows were running at the time on fairly good pasture, but ate the clover silage with avidity.

To determine how much well cured clover hay was represented by the silage, 4,691 pounds of green, freshly cut clover was spread out to dry on the 8th of July. On the 10th it was cured sufficiently to draw to the barn. It then weighed 1,960 pounds. On the 12th of November, when it was taken out for feeding, it weighed 1,740 pounds, or 37 per cent of the original weight. The 2,773 pounds of silage represented, therefore, 1,026 pounds of well cured hay. The chief objection to putting the clover in the silo is that it is slow and expensive work to draw to the barn so much water. The green clover is inconvenient to handle, is raked up with difficulty and makes hard work pitching on and off the wagon. The comparative losses of field curing and siloing have not been determined.

This trial of clover silage was a repetition of a similar test of a previous year. All that is shown by these tests is that it is possible to ensilo clover, that the silage keeps well and that stock will eat it with evident relish. Nothing can be added to the value of the clover by the process,

but probably the losses in the silo are no greater than when the crop is field cured. The expenses of harvesting are, however, much greater, when the weather is fine. It is cheaper to allow the sun to dry the hay than it is to draw the green forage to the barn. There is, of course, less risk in bad weather with the silo than by the older method.

VARIETIES OF CLOVER, METHODS OF CULTURE AND YIELDS.

The seed was selected after careful inspection to prevent the introduction of such weeds as buckhorn plantain, and was sown on the growing wheat in the spring of 1896, during the month of April, and, as far as possible, in the first week of that month. Experiments carried on for two sucessive years had demonstrated that in ordinary seasons the earlier the clover seed is sown in the spring the greater the probability of a full crop. The seed was sown in the early morning, while the ground was frozen and while the air was still; a wheelbarrow seeder and various hand devices were used in scattering the seed. On the north half of field 9, pure medium red clover was sown; on the south half of the same field mammoth clover, and on field 12, which contains a great variety of soils, alsike seed, mixed with various grasses. The season of 1896 was favorable on the whole to the growth of the clover plants, which, after the removal of the wheat crop, grew so rapidly as to necessitate running a mower over the field and the removal of nearly a ton to the acre of hay in the fall of 1896.

Neither cattle nor sheep seemed to like this fall crop of clover, although secured without exposure to rain. It was stored in the barn, and the attempt to feed it was made in the cold weather of winter, with but very partial success. The dairy cows rejected it, and the lambs would not eat enough of it to make a respectable growth. It had to be used, therefore, largely for bedding. Its removal was, however, necessary, to prevent smothering the clover plants during the winter.

The winter of 1896-97 was favorable to clover, and the crops made a good growth and were ready for the mower by the last week in June. On the 23d of that month a measured acre on the west end of No. 9 was cut and field cured. The yield was 4,200 pounds of hay in good condition to go into the barn. Field 12 was used as a pasture through the season. The field contains 34 acres. On it 18 head of growing cattle were pastured from the early part of May through the season. Mowers were put in the field June 24th, and the hauling of the hay was completed on the 30th. The yield for the 34 acres was 35 tons, 1,940 pounds of field cured hay. No rain fell while the crop was being gathered, and the hay was of most excellent quality, green in color and free from dust.

The yield from field 9, 23.8 acres, was 53 tons, 1,677 pounds, or two tons, five hundred and twenty-four pounds per acre. No tests have been made of the relative feeding value of the hay from medium, alsike and mammoth clover. The practical identity in composition of red clover and alsike hay is *prima facie* evidence that they are of practically equal value. Mammoth clover hay is not eaten as clean as medium, because of its woody stems.

Crimson Clover.—The attempt has several times been made on the Station grounds to grow crimson clover as a forage plant. It has been sown usually in the fall or late summer. It has been usually either entirely killed by the winter, or so far injured as to make it impracticable to leave the remnants for harvest. On April 26th, 1896, ten pounds of crimson clover seed was sown on the north east half acre of field 8. The seed was sown with a grass seeder and harrowed in with a light slanting tooth harrow. The plants were slow in making their appearance, but by the 13th of May the ground was well covered. The early part of June was warm and wet, facilitating its growth. The crop was cut with a mower on the 24th of June and weighed, a sample being taken for the determination of moisture. The yield of the half acre was 1,870 pounds, containing 77.41 per cent of moisture. The yield of dry matter per acre was, therefore, 844.87 pounds. The weather continuing moist and warm, the crimson clover made a very rapid second growth. When pastured by sheep along with an adjacent field of rape, the latter was much preferred to the crimson clover, which, however, was pastured close after the rape was exhausted. Notwithstanding this ill treatment, the crimson clover withstood the winter well, and covered the ground with a green coat in the spring of 1897. No feeding experiments were tried with crimson clover hay.

Vetches.—April 27, 1896, one-half acre was sown with a grain drill to vetches and oats, 25 lbs. of vetches and 32 of oats being used. The oats germinated much the more rapidly and hardly a plant of the vetch was seen until the oats were harvested. The field notes record, under date of June 9th, that the vetches were making but a poor growth as the oats were far above them. On July 6th the oats and vetches were ready to cut, the oats being fully headed and ready to turn. Because the vetches had made such meager growth, however, the harvesting of the plot was delayed to July 29th, when the oats were fully ripe. The crop was drawn to the barn August 1st, when it weighed, in rather damp condition for storing, 2,132 pounds. As soon as the oats were removed the vetches began to show themselves. The field notes through August show that they grew rapidly and completely covered the ground before the close of that month. There was a severe frost on September 19th, which did not injure the vetches, though it stopped the growth of the second crop of sorghum on adjacent plots. The vetches were cut and fed to sheep, which did not seem to like them and would not eat them until practically forced to do so. The continuous rains made it impracticable to harvest the vetches for hay, and no feeding experiments could therefore be conducted during the winter with this crop. Where the heavy fall growth was mown and removed the vetches withstood the winter and were green in the spring of 1897, but where it was left on the ground the plants were entirely smothered. The crop is worthy of further trial because, among other reasons, it belongs to the great family of plants that have the ability to utilize the nitrogen of the air. By the decay of its roots it leaves in the soil available for other plants, a large amount of this most costly manurial element which it has gathered during the period of its growth.

Peas.—To supplement the pasture in case of drouth and to afford a most excellent hay if not needed for summer feeding, it is the custom on

the college farm to sow some considerable area to peas, usually with oats. The ground is prepared in the fall and the seed put in the ground at the earliest possible moment in the spring. Two bushels of peas are used per acre. If in the latter part of March the surface of the ground is sufficiently dry the peas are either sown broadcast on the surface and plowed under three to four inches deep or put in with a grain drill as deep as possible. The oats are sown shallow later at the rate of one bushel of oats to the acre. Careful records are not at hand to show the yield per acre of this crop, nor have comparative feeding trials been instituted to determine its relative value compared with clover hay or other forage crops. Experience has demonstrated that cattle like the hay and that they eat it in sufficient quantities to produce a full yield of milk and butter. On several occasions the crop has been harvested into a silo, making a silage richer in protein than any other silage fed at the station. Its per cent of dry matter when fed was 49.92 and its per cent of protein fully 4.5 per cent. When first put in the silo, owing to unusual succulence, the peas and oats make a very wet silage. If the silo is not absolutely tight much of this juice escapes, and the silage when fed is correspondingly dry.

Alfalfa.—The plot of alfalfa, the behavior and yield of which has been reported in previous bulletins of the Station, was completely destroyed by the severe weather in the early months of 1897. In May hardly a root was left alive, and scarcely a green stem showed above the ground.

Rape.—A half acre of rape was sown in the spring of 1896 in the east end of No. 8, by the side of a similar area of vetches and oats, and near the half acre plots of sorghum and fodder corn, the yields of which are reported on page 98. Three pounds of rape seed were sown April 23d, with a wheelbarrow seeder and the ground was gone over with a light harrow the next day. No further cultivation was given the crop, which was cut and put in the silo June 24th. The total weight of green rape was 6,955 pounds, containing 80.75 per cent of moisture. The yield of dry matter per acre was therefore 2,677.67 pounds. The cows ate the rape silage with evident relish, and no taint was imparted to the milk by it. Further experiment will be necessary to establish the practicability of rape either as green fodder or as silage, for a cow feed. After the removal of the first crop of rape it sprang up again quickly, and was pastured with the half acre of crimson clover adjoining, through the fall. On August 10th it was noted that the sheep much preferred the rape to the crimson clover, and that they had eaten the former well into the ground before attacking the latter, the flock having been put on the field July 27th.

Millet and Hungarian Grass.—In former bulletins of this Station the investigations in regard to the methods of growing these grasses and the adaptability of the many varieties have been fully discussed. The millet grown on the farm has been fed for the most part as hay. On one or two occasions the green fodder has been put in the silo. The silage is liked by the cows, and when fed keeps up the flow of milk and butter. It is unusually dry for silage, containing, as it did in 1896, but 57.10 per cent of water. When pitched out of the silo it was light and fluffy, resembling hay rather than silage. It had a pleasant odor and kept with

very little spoiling. Millet is to be recommended to every dairyman because it can be sown late in the season after a crop of peas and oats has been removed, or can be substituted for corn when the spring work has been so delayed as to make the planting of the latter impracticable.

Mangolds, Carrots, Sugar Beets and Rutabagas.—Where silage is not used it is wise for the dairyman to provide succulence for the winter ration in the shape of some kind of roots. The three which suggest themselves as probably yielding the most food products for the labor and money expended in growing them are mangolds, sugar beets and carrots. Turnips and rutabagas need be used in the dairy with extreme caution, because of their liability to impart an unpleasant taint both to the milk and to the products made from it. It is true undoubtedly that rutabagas can be fed to dairy cows in such a way as to avoid this taint in the milk. But precautions as to the manner or amount have to be taken, and sometimes this precaution is apt to be neglected, with the result that the sample of butter is injured and perhaps a customer permanently offended. The reasonable use of the other roots is attended with no such danger, and for this reason they are recommended to be grown by all dairymen, whether possessed of a silo or not. The area devoted to them need not be large, but roots add a needed variety to a winter ration and repay their cost in the increased healthfulness of the cow as well as in the butter produced.

An experiment was tried during the summer of 1897 to compare the cost of growing and yields per acre of ox heart carrots, yellow tankard mangolds, long red mangolds and rutabagas. The plot devoted to the experiment contained three quarters of an acre. The rows were 22 inches apart and 30 rods long. One quarter acre was planted to ox heart carrots, the adjoining quarter to the mangolds, one eighth to the tankards and one eighth to the long reds, and the remaining quarter to rutabagas. The yields per acre were as follows:

Yields of roots per acre.

	Yield per plot	Yield per acre.	Dry matter.	Dry matter per acre.
	lbs.	lbs.	%	lbs.
Carrots	7,209	28,836	11.52	3,321.90
Long red mangolds	3,208	25,616	13.20	3,381.30
Tankard mangolds	2,718	21,744	9.71	2,111.30
Ruta bagas	7,757	31,028	12.06	3,741.98
Sugar beets	....	28,320	18.88	5,346.80

The largest yields, both of gross weight and dry matter, is given by the rutabagas, the long red mangolds following next. The average yield per acre of four acres of sugar beets adjoining was 28,320 pounds.

The mangolds were sown May 10th, using 9.6 pounds of seed per acre. The carrots were sown the same day, applying two pounds of seed to the acre. The rutabagas were sown May 17th, 2.8 pounds of seed per acre. The ground had been in corn the year before, and was

thoroughly subsoiled in April. The cost of preparing the ground, marking, planting, cultivating, thinning and hoeing, was practically the same per acre for all the roots. The work per acre may be tabulated as follows:

Labor per acre in growing roots.

	Man and team. Hours.	Man. Hours.
Plowing and subsoiling	12	
Harrowing	3.75	
Marking	.8	
Planting		3.25
Cultivating	15	
Thinning and hoeing		75.90
Harvesting	1.25	130.75
	32.80	209.90

The hand labor in harvesting was performed by boys at eight cents an hour. The 79.15 hours spent in hoeing and thinning was done by men at twelve and a half cents an hour. The team work is reckoned at twenty-five cents an hour for man and team. At these prices the cost of labor for growing and harvesting an acre of roots was $28.55. The labor of harvesting an acre of mangolds was appreciably less than for an acre of sugar beets or carrots. The cost of labor per ton of carrots was slightly less than $2.00 per ton, of rutabagas $1.84 and of mangolds $2.51. The season was unfavorable to the growth of mangolds, on account of the long and severe drouth, but the other root crops were subjected to exactly the same conditions.

On page 98 the yields per acre of dry matter by sorghum and silage corn on the same field the previous season were 7,700.39 for the sorghum and 8,655.85 for the silage corn.

It has been demonstrated by many experiments in several experiment stations, that sugar beets are one of the best of root crops to feed to live stock, either dairy cows or fattening animals. Cows are very fond of them, and their great richness in sugar and other completely digestible carbohydrates make them a very valuable stock food. Owing to the fact that they grow deep in the earth it is more costly to harvest them than other roots, but this is compensated by their greater richness in sugar.

Effect of Roots and Potatoes on the Digestibility of Rations.—As shown by the rations reported on page 90, roots have formed no inconspicuous part of the ration, even when ensilage is fed. It is interesting to note whether the addition of roots to a ration affects the digestibility of the ration, and in the second place, what effect such addition has upon the quality of the butter. Upon the first point a digestion experiment was conducted at the station by Prof. C. D. Thompson of the Oregon Agricultural College, in the spring of 1896, while he was doing post graduate work. The essential facts of this experiment carried out by Mr. Thompson, under the supervision of the director and chemical department of the station, are reported below.

Two cows were used, Halo, a grade Jersey, six months in the period of lactation, and weighing 750 pounds at the beginning of the experiment, and Milla, a grade Shorthorn, three months in milk, and weighing 950 pounds. The basic ration was made up of 14.5 pounds of clover hay, 6.5 pounds of corn meal and 6.5 pounds of wheat bran per thousand pounds live weight per day. The usual precautions were taken to secure representative samples, and analyses were made of the feeding stuffs used, with the following results, the figures under ash, protein, crude fiber, N. free extract and fat referring to the proportion of these constituents in the dry matter and not in the original substance.

Composition of feeding stuffs.

	Dry matter. Per cent.	Ash. Per cent.	Protein. Per cent	Crude fiber. Per cent.	Fat. Per cent.	N. free extract. Per cent.
Bran	87.2	4.3	15.69	4.84	4.0	71.17
Corn	87.8	1.6	13.18	2.30	5.2	77.71
Mangolds	9.5	10.3	15.31	7.00	2.00	65.39
Potatoes	21.00	6.7	12.87	2.31	.70	77.42
Hay	88.00	7.2	12.75	36.00	4.20	39.85

After a preliminary period of 11 days, in which the cows were fed upon the rations to be used in the first period of the actual experiment, the first feeding period began. During its continuance the cows were fed mangolds, with the ration of hay, cornmeal and bran. An intermediate period followed, in which the mangolds were gradually removed and the cows prepared for Period II, in which no roots were given. At the close of this period the ration was again gradually changed by the addition of potatoes. It required ten days to accustom the cows to the new ration, after which the third period of the test began. In Period I the daily ration was composed of 14 pounds of clover hay, 6 pounds bran, 6 pounds of corn meal and 20 pounds of mangolds. In Period II the ration was 14.5 pounds of clover hay, fed with six and one half pounds each of bran and corn meal. In Period III the ration was 12.5 pounds of clover hay, 6 pounds of bran, the same of corn meal and 15 pounds of potatoes. The cows were fed their weighed rations at seven a. m., and 5 p. m., in tight boxes on an elevated platform. The stalls were thoroughly cleaned at the beginning of each period, and the cows were placed in charge of attendants both day and night, whose duty it was to collect separately the solid and liquid excrements. Records were kept of the weights of each excreted and also of the weight of milk yielded at each mess. A sample of the milk was put in a glass can and the composite sample analyzed at the end of each three days.

The duration of Period I was six days, of Period II six days and of Period III four days. The following tables show the amount of hay, grain and roots consumed by Halo and Milla in the three periods, and the amounts of dry matter, ash and nutrients which they contained:

Name.	Period.	Hay.	Corn.	Bran.	Roots.	Dry matter.	Ash.	Fat.	Crude protein.	Crude fiber.	N. free extract.
		lbs.	lbs	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Halo	I	63	27	27	90	111.24	6.27	4.67	15.18	22.25	62.87
Milla	I	84	36	36	120	148.30	8.85	6.22	20.26	29.66	83.81
Halo	II	66	30	30	......	110.58	5.73	4.86	14.97	22.78	62.24
Milla	II	87	39	39	......	144.80	7.51	6.36	19.60	29.99	81.34
Halo	III	38	18	18	45	74.39	3.97	2.91	10.01	13.38	44.12
Milla	III	50	24	24	60	98.60	5.25	3.88	13.29	17.62	58.56

These tables show a remarkable uniformity in the consumption of dry matter. In Period I it was on the average 24.71, in Period II 24.13 and in Period III 24.65 pounds per day per thousand pounds live weight, a variation of only .58 of a pound.

The weight of Halo remained constant at 741.6 pounds during the first period, dropped to 733.6 during the second and to 722 during the third. That of Milla shrank from 939.6 to 913.3 during the first period, increased in the intermediate period to 952.3, dropped again to 922.3 during the second period, and gained from 932 to 937 during the third period. A record was made of the amount of water drunk each day, and these fluctuations in weight were due in the most part to the variations in the amount of water drunk. In only one instance was there a striking variation in weight which could not be accounted for, and that was the loss of 30 pounds on the part of Milla in Period III, and even in this case it was noted that the cow drank more than 30 pounds more water on the day of the beginning of that period than on the day of its close.

It is evident that the parts of the food which passed through the system undigested and appearing in the dung should be subtracted from the whole amount of that constituent fed in order to determine the amount of it absorbed into the system and utilized by the animal. Hence in the following table there is contrasted the amounts of dry matter, of ash and of each of the nutrients consumed by each cow in each period, and the amounts of each that appear in the dung of each cow for each period. The differences will give the pounds digested. This is done in the following table; in which, since Period III lasted but four days, the figures for that period are multiplied by one and a half, the more readily to compare with the figures for the other periods, which were one and one half times as long.

Derivation of coefficients of digestibility.

	Dry matter.	Ash.	Fat.	Crude fiber.	Crude protein.	N. free extract.
Halo—Period I:	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Consumed	111.24	6.27	4.67	22.25	15.18	62.87
Returned in dung	37.13	3.21	1.19	11.36	5.94	15.43
Pounds digested	74.11	3.06	3.48	10 89	9.24	47.44
Per cents digested	66.62	48.80	74.52	48.94	60.87	75.45
Milla—Period I:						
Consumed	148.30	8.35	6.22	29.66	20.26	88.81
Returned in dung	50.78	4.38	1.93	13.71	8.06	22.70
Pounds digested	97.52	3.97	4.29	15.95	12.20	61.11
Per cents digested	65.76	47.54	68.97	53.78	60.22	72.91
Halo—Period II:						
Consumed	110.58	5.73	4.86	22.78	14.97	62.24
Returned in dung	40.11	3.25	1.02	11.91	5.89	18.04
Pounds digested	70.47	2.48	3.84	10.87	9.08	44.20
Per cents digested	63.73	43.28	79.01	47.71	60.65	71.01
Milla—Period II:						
Consumed	144.80	7.51	6.36	29.99	19.60	81.34
Returned in dung	51.32	4.16	1.32	15.07	7.86	22.91
Pounds digested	93.48	3.35	5.04	14.92	11.74	58.43
Per cents digested	64.55	44.60	79.23	49.75	59.90	71.83
Halo—Period III:						
Consumed	111.59	5.95	4.37	20.08	15.02	66.17
Returned in dung	44.79	3.25	1.66	13.01	6.63	20.24
Pounds digested	66.80	2.70	2.71	7.07	8.39	45.93
Per cents digested	59.86	45.37	62.01	35.20	55.85	69.41
Milla—Period III:						
Consumed	147.90	7.87	5.80	26.45	19.94	87.84
Returned in dung	49.36	3.98	1.82	15.17	8.40	19.99
Pounds digested	98.54	3.89	3.98	11.28	11.54	66.85
Per cents digested	66.62	49.23	68.62	42.64	57.87	77.24

The digestive work of the two cows was wonderfully uniform, not differing essentially in the digestibility of any constituent of the ration in either period. We are safe, therefore, in taking the average per cent of digestibility in each case. The following table gives the average per cents of digestibility for the various factors in each period:

Coefficients of Digestibility,

	Dry matter.	Ash.	Fat.	Crude fiber.	Protein.	Nitrogen free extract.
Period I	66.19	48.17	71.74	51.36	60.54	74.18
Period II	64.14	43.97	79.12	48.73	60.27	71.42
Period III	63.24	47.40	65.32	38.92	56.71	73.33

In passing from Period I to Period II it is evident that the removal of the beets from the ration decreased the digestibility of the dry matter, ash, crude fiber and N. free extract, while the digestibility of the protein remained constant. The addition of potatoes to the ration still farther decreased the digestibility of the dry matter of the crude fiber, and markedly lowered the digestibility of the protein. This result is undoubtedly due to the fact that potatoes are nearly clear starch, and the addition of so much starch to a normal ration lowers the digestibility of the protein, the fat and the crude fiber. There is a real and apparent discrepancy in the work of the two cows and the results they show in the coefficients of digestibility in Periods II and III. Whereas Halo digested a greater per cent of every constituent of the ration except the ash in Period II than in Period III, Milla, while agreeing with Halo as to the ash, fat, crude fiber and protein, digested, on the other hand, more of the dry matter and nitrogen free extract in Period III than in Period II.

Effect of Potatoes and Roots on the Quality of the Butter.—In the winter of 1896, in the months of November, December and January, an experiment was performed to test the effect of feeding beets or potatoes with a ration consisting otherwise of clover hay, corn stalks and a grain mixture of one part oil meal, two parts oats, three parts bran and four parts corn, or one part oil meal, two parts corn, three parts bran and four parts oats, since both combinations were used during the progress of the experiment. The five cows, College Pauline America, College Houwtje, Cara, Milla and Halo, were used for the experiment. For the period beginning November 13th and ending December 1st no roots of any kind were fed. The milk of these cows from November 29th to December 2nd, was saved separate from the rest of the herd, churned separately and the butter analyzed and tested for hardness. From December 2nd to December 22nd, mangolds were fed, in addition to the ration of hay, cornstalks and grain.

The periods were too short to note any material changes in the quantity of butter fat yielded or to establish any relation between feeding roots and potatoes and variations in the yield of butter fat. The analyses of the butter and the records of the churnings do show, however, variations due to the influence of the potatoes or mangolds. The average per cent of fat lost in the buttermilk when the cows were fed nothing but dry food was .022, when mangolds were added it was .027, when potatoes were fed it was .025. Here the variation was immaterial. The average acidity of the cream was from 40 to 42.2 c. c. of decinormal to the 50 c. c. of cream and was not different in the three periods. The average temperature of the cream when the churning was complete was on dry feed 58.8, on mangolds 59.6 and on potatoes 59.3. The average time required for churning was on dry feed 34 minutes, on mangolds 36 minutes and on potatoes 86 minutes. On this point there was a very marked difference due to the feeding of potatoes. The cream frothed badly in the churn and it took more than twice as long to bring the butter. The chemical analyses of the butter in the different periods is reported in the table below, in which the hardness is determined by dropping a steel rod

weighing 50 grams, 7 millimeters in diameter and 203 millimeters long dropped two meters. The distance the end of this rod penetrates the butter measures its softness. The farther the rod penetrates the softer the butter.

Composition of Butter from Dry Feed and from Potatoes.

	Water per cent.	Ash and casein per cent.	Fat per cent.	Volatile fatty acids, c. c.	Melting point centigrade.	Hardness, m. m.
I Dry food	8.28	2.85	88.86	26.5	32.6	18.7
IV Dry food	6.93	3.36	89.01	30.4	----	15.3
Mangolds	8.24	2.63	89.13	27.6	32.23	16.7
III Potatoes	6.37	3.50	90.13	28.0	----	18.7
V Potatoes	5.42	3.03	91.55	33.4	32.4	12.3
Average potatoes	5.89	3.26	90.84	30.7	32.4	15.5
Average dry food	7.60	3.07	88.93	28.45	32.6	17.00

Potatoes did not constitute an abnormal proportion of the ration and no important difference is noted in the composition of the butter that could be ascribed to the potatoes. In one case the butter was much harder where the cows had the potatoes, in another it was as soft as when the cows were on dry feed. The per cent of volatile fatty acids, the ingredients that give butter its characteristic flavor, was slightly higher on the average in the potato butter than in the butter from dry feed.

Corn Meal.—Corn meal has been an ingredient of nearly every grain mixture fed the college dairy cows for the past three winters, and this notwithstanding the fact that silage has formed the bulk of the ration. At the ordinary market prices it furnishes digestible nutrients cheaper than any other grain or by-product. While relatively low in protein, it can be used to good advantage with clover hay and wheat bran or oats, the oats or bran supplying the protein necessary to balance the ration. When the corn has not been mixed with oats or bran the cob has sometimes been ground with the kernel to make a meal less compact and of less specific gravity. Corn cobs have little feeding value, and it would rarely pay the farmer to cart them to mill and pay for grinding them, where he pays for the grinding by the hundred, but where the grinding is done by windmill or other cheap power on the farm itself, it will pay to grind the cob with the corn to act as a diluent. In such cases the cob must be ground very fine.

With silage, corn has usually been mixed with linseed or cotton seed meal, bran and oats, in the proportion of two parts of corn meal to eight of the other grains or by-products. Not infrequently the corn has been fed the cows unhusked and with the stalks. In that case the shocks have been drawn directly from the field, run through a cutting box and fed with wheat bran and clover hay. A good proportion of kernels escape digestion, and for the sake of economy it has been found necessary to follow the cows with pigs to consume the corn in the droppings. Where human labor is high in price and corn relatively cheap this method recommends itself.

Gluten Meal and Gluten Feed.—Several tons of gluten meal have been feed at the station, and since the feeding stuff is comparatively new to the state, a reference to its value and place in the ration is here made. These gluten feeds are the residue from the manufacture of either glucose or starch, and differ in composition, according to the method of manufacture and to the thoroughness with which the starch is extracted in the process. These methods of manufacture differ very materially in their results but they consist essentially in the separation of the outer coating of the kernel and the germ from the interior starchy portion. This is done by machinery and by soaking the crushed kernels in water. In the process the germ may or may not be separated from the gluten and the skin. The gluten in the kernel resides in the layer of cells immediately beneath the skin. If the corn is yellow these gluten cells are yellow. They are characterized by a high content of both protein and fat. The germ occupies the point of the kernel, from which the sprout comes as the kernel germinates. It is rich in oil and gluten.

Cross sections of a kernel of corn showing the skin, immediately below the skin a layer of gluten cells, next the mass of starch in the interior, hardened at the sides and finally the germ near the point but not projecting from it.

Prof. E. B. Vorhees, of the New Jersey Experiment Station, reports in Bulletin 105, of that station, page 7, the analyses of the kernel of corn, of the skin, of the germ and of the starchy and hard parts, in the following table:

Station number.		Amounts secured from 100 parts of original corn.	Per cent of water.	Fat.	Crude fiber.	Protein.	Ash.	Carbohydrates.	Nitrogen.	Phosphoric acid.	Potash.
905	Original corn	100.00	24.74	4.34	2.03	12.65	1.73	79.26	2.02	.83	0.47
906	Skin	5.56	15.29	1.59	16.45	6.60	1.27	75.36	1.06	.23	0.38
907	Germ	10.17	29.62	29.62	2.88	21.71	11.13	45.79	3.48	6.16	2.91
909	Starchy and hard parts	84.27	24.66	1.54	.65	12.23	.68	85.58	1.96	.35	0.17

"The germ, although only about 10 per cent of the whole kernel, contains 65 per cent of the fat, 61.5 per cent of the mineral matter, 71 per cent of the phosphoric acid, 60 per cent of the potash and 16.33 per cent of the nitrogen or protein. The remaining portions are characterized, the skin by the content of fiber, 51 per cent of the whole, and the starchy parts by the carbohydrates, of which it contains nearly 90 per cent of that in the whole grain."

It is evident from these analyses that the composition of the by-products made from corn depends on whether more or less of either the germ, the skin or the starch is left in them. If the starch alone is removed the trade name of the product is gluten feed. The germ ground alone is called germ meal. The gluten cells alone or with the germ is called gluten meal. These names are used, however, indiscriminately, and it is quite impossible to gather any correct idea of the composition of these by-products from the names alone. The gluten meal should be richer in protein than the gluten feeds. Below are given the analyses of gluten feeds and gluten meals, taken from the Bulletin 105 of the New Jersey Station, to which reference has been made:

Name.	Pounds per hundred of—					
	Water.	Crude fat.	Crude fiber.	Crude protein.	Crude ash.	Carbohydrates.
Chicago gluten feed	7.61	14.18	6.31	24.03	0.87	47.00
Peoria gluten feed	6.94	14.84	7.11	22.64	.97	47.50
Buffalo gluten feed	10.20	13.67	7.17	22.65	.84	45.47
Average of seven samples	8.32	12.74	6.84	21.61	.86	49.63
Cream gluten meal	7.37	15.64	1.45	41.76	1.58	32.20
King gluten meal	9.36	19.77	1.47	35.09	1.90	32.41
Iowa golden gluten meal	7.61	12.65	3.60	30.47	1.00	44.67
Av. of five samples	8.15	14.06	1.66	32.83	1.31	41.99
Av. of three samples Chicago gluten meal	9.49	5.56	1.50	35.79	.86	46.80

These analyses show how variable in composition these by-products are, and dairymen should exercise due caution in their purchase for that reason. At the prices at which they are usually sold the gluten meals furnish protein fully as cheaply as does any other by-product. Cows, while not exhibiting an especial fondness for gluten meal, have seldom refused it when mixed with other feeds. At the college dairy barn it has been fed in amounts as high as four pounds per day, with good results.

For two successive winters experiments were conducted to test the influence of gluten meal on the quality of the butter. It was found as an invariable result that the gluten meal made the butter softer and made it difficult to so churn the cream as to extract all of the butter from the buttermilk. The per cent of fat in the buttermilk invariably increased from .1 per cent to .25 per cent, or even .5 per cent when gluten meal was fed.

Linseed Meal.—There are offered in the markets two classes of linseed meal, old process and new process. Both have been fed at this station with good results. They have been used as a source of protein and to give variety to the ration. Ordinarily the amounts fed per day have been less than two pounds and seldom more than one. In exceptional cases, as in that of Rosa Bonheur, as high as six or more pounds per thousand pounds live weight per day have been fed without injury. The high price of the product prevents its more extended use. The cows prefer the coarsely ground oil cake, the so-called pea size old process linseed meal to the finely ground.

No effect of the introduction of linseed meal on the quality of the butter appears in the records of the dairy work at the station. Fed as it is in connection with a variety of grains, no such effect could be expected.

Cotton Seed Meal.—This by-product heads the list as far as richness in protein is concerned. Its price is usually somewhat higher than that of linseed meal, but ordinarily it will furnish protein fully as cheaply, if not more so, than the by-products of the linseed oil mills. Experience in its use at this station will warrant its recommendation to dairymen to be fed in amounts not larger than two pounds per cow per day. Fed in this way, it supplies a large amount of digestible protein and gives the cow an appetite for the coarser forage plants, like cornstalks or even straw. In purchasing cotton seed meal care should be exercised to see that the indigestible hulls of the seed have been removed.

The feeding of cotton seed meal is usually accompanied by an increased hardness of the butter. If fed in excess, the quality of the butter suffers, as does also the health of the cow. Common-sense, however, will prevent the misuse of a food so inordinately rich in protein.

Wheat Bran—Letters received at the station indicate that in some parts of Michigan a prejudice exists against roller process wheat bran, while elsewhere an equal prejudice is found in its favor. Some farmers prefer finely ground bran, others like better the coarser samples. The product of roller mills is not uniform as to fineness of flakes, some turning out at times a very light and flaky product and at other times bran more finely ground. In some samples of roller process bran the germ is ground with it. In the burr stone process the germ is ground with the flour. In the roller process the wheat is not infrequently dampened before grinding to toughen the outer coats of the kernel and to bring away the bran in as large particles as possible.

In the spring of 1897 the analyses of 14 samples of bran were made by Mr. Lewis S. Munson, and the results presented as his graduating thesis. The work was done under the close supervision of the chemical department of the station, with all the usual safeguards against error. Later three samples of bran were sent to the station from Minneapolis as typical specimens of the first, second and third grades of bran which the large mills turn out. These samples were also analyzed by the chemical department of this station, and the results are given in the tables below, following the analyses reported by Mr. Munson.

Analyses of wheat bran.

Number.	Process.	Annual output.	Protein.	Ash.	Water.	Fat.	Crude fiber.	Starch.	N-free extract.
			per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.
1	Burr	100 bbls. daily	16	5.34	9.82	1.18	10.03	45.96	57.51
2	Roller	100 bbls. daily	15.38	5.97	10.92	1.89	11.76	40.05	54.06
3	Roller	1,000 tons	15.00	7.01	11.39	1.79	10.72	42.33	54.09
4	Roller	2,000 tons	17.56	5.90	8.01	3.84	9.70	38.61	54.99
5	Roller	2,500 tons	17.56	5.58	8.17	2.96	9.69	42.21	56.04
6	Roller	1,600 tons	14.82	5.59	10.24	3.31	11.23	39.57	55.32
7	Roller	1,200 tons	17.63	5.56	9.14	2.85	10.40	41.49	54.42
8	Roller		16.25	5.83	8.04	3.31	10.19	44 28	56.38
9	Roller	2,000 tons	15.63	6.83	8.65	2.81	12.28	39.06	53.80
10	Burr		16 13	6.17	8.65	2.15	10.90	42.66	56.00
11	Roller	90,000 bbls.	14.75	6.36	8.70	2.54	11.93	40.23	55.64
12	Roller	66,000 bbls.	16.38	6.38	9.72	3.09	10.40	38.43	54.03
13	Roller	2,500 tons	16.94	5.78	8.02	3.20	11.36	43.47	54.70
14	Roller	5,000 tons	17.13	6.33	8.01	2.96	10.81	44.64	54.76
15	Roller, first grade		19.00	5.48	12.38	3.88	9.31		62.33
16	Roller, second grade		16.81	7.67	13.06	3.99	13.90		57.63
18	Roller, third grade		17.13	7.67	13.56	4.57	14.36		56.27

These analyses show us in the first place that over half of the total weight of bran consists of carbohydrates, very largely starch. Second, the richer the bran is in protein the poorer in crude fiber. Third, burr stone bran differs from roller process in containing less fat, due undoubtedly to the fact that it does not contain the germ. Fourth, little variation in its composition is discernable between the samples of extremely coarse bran, like samples 1 and 3 on the one hand, and the fine brans like sample 2, on the other. Mr. Munson says on this topic: "The two extremes, the very coarse and the very fine, are of much the same composition, while neither shows by any means the best sample of bran so far as feeding properties are concerned. The medium grade brans generally show a far better analysis than either of the former." "Theoretically the bran produced by the roller process should be a more valuable food than that produced by the burr stone process, as in the one the germ, which is rich in fat, is separated out with the flour, and in the other this part goes into the bran. This the investigation emphatically bears out. The roller process brans are all perceptibly higher in protein than are those of the burr stone process, and as bran is given as a proteid food, this fact is worthy of consideration. It is not so much the amount of starch present in the bran, as the amount of protein and fat, that is of consideration to the feeder. The end, therefore, for which the millers are constantly working in the milling process, the most complete separation of the starch possible and the needs of the consumer of the bran, namely, a food rich in protein and fat but not necessarily containing much starch, are identical. The new milling process, instead of supplying the feeder with an inferior grade of feeding stuffs, furnishes him with one much superior to that furnished by the old process. The investigation thus credits the production of the better bran to the new or

roller process. It shows that the brans rich in starch will be relatively low in fat; that there is also an inverse variation between the protein and the crude fiber; that no marked variation is to be found in the amount of ash; that there is a considerable variation in the composition of the bran produced by the roller process, but that the relative feeding values of these brans are not widely divergent."

The first grade bran from Minneapolis was much the coarsest of the three samples and had a distinctly harsher feeling. It was nearly two per cent richer in protein than either of the others, had a smaller content of fat and of crude fiber and a much larger content of starch. These differences in chemical composition would warrant a slight difference in price in favor of the first grade.

DAIRY BARN.

During the summer of 1897, a new dairy barn was built to hold a grade herd of thirty cows. The plan outlined by the Board involved the erection of the building at the smallest possible cost consistent with efficiency.

The barn is rectangular in form, seventy feet long, north and south, and forty-five feet wide east and west. A driving floor ten feet wide runs lengthwise through the center of the barn, connecting doorways at the middle of the north and south ends. Over this driveway a wagon is driven to haul out the manure. On each side of this center driveway is a gutter sixteen inches wide, four inches deep at the north end of the barn and six inches deep at the south end. The floors on each side of the gutter lap over it, so that liquids falling on them are compelled to escape into the gutter. The bottom and sides of the gutters are two-inch plank, jointed and fitted together water tight.

Running along the edge of each gutter farthest from the center of the driveway is a stone wall upon which stands a row of posts which serve a twofold purpose. They sustain the weight of the hay mow and at the same time serve as the rearmost post of the partitions between the cows. These posts stand upon a two by six hemlock plank which rests upon the wall. The gutter side is spiked to this plank so that the post is two inches in from the edge of the gutter. The spaces between the foundation walls were filled with sand and the floors placed directly upon this sand with no joists except two by four or two by six strips to which the floor plank could be nailed to hold them in place. The floors are level except that of the center driveway which is arched one inch in the middle to compel any water that falls upon it to run quickly into the gutters. The floors are of first class hemlock plank, jointed and dressed on one side.

From the edge of the gutter to the side of the barn is 16 feet making feeding alleys in front of the cows eight feet wide, allowing for an abundant circulation of air and giving plenty of room for convenience in feeding.

The milk and wash rooms are in the northwest corner of the barn and are, together, 16 feet by 8 feet, running from the gutter to the west side

of the barn. A sliding door next the gutter keeps the odors of the barn from the milk room to which access from outside the barn is gained by another sliding door four feet wide on the north end of the barn.

Two box stalls for calves and incoming cows are adjacent to the milk room and extend from gutter to feeding alley. They are each 10 feet by 8 feet.

Across the central driving floor from the milk room, in the northeast corner of the barn is a granary, 8x16 feet, extending from the gutter to the east wall of the barn and therefore occupying that entire corner.

In the middle of the barn north and south two stalls on each side are left vacant and the partition removed to make a connecting alleyway between the feeding alley on each side and the central driveway.

The frame of the barn consists of a row of upright two by sixes, sixteen feet long, standing on the 2x8 sills. These upright two sixes stand two feet apart and against them on the outside the matched siding is nailed.

In the west side of the barn there are ten windows, one every seven feet, in the east side but nine, there being no window in the granary. The distance from the main floor to the bottom of the supports to floor of the mow over the cattle is 9 feet. These upper 2x10 floor joists are spiked to the upright two by sixes of the frame at one end and rest upon a beam supported by the row of posts standing between the cows at the edge of the gutter, at the other. This beam is made by spiking together three two by sixes side by side.

The rafters are spliced two by sixes supported by proper purlin plates which in turn rest upon short posts resting on a cross beam on the floor of the mow, which beam is vertically above the beam supported by the row of posts between the cows on the edge of the gutter.

The roof is of steel.

The cost of the barn, exclusive of painting, was as follows:

Foundation, stone and labor	$41.22
Lumber and windows	426.24
Carpenter work	101.00
Roof	122.10
Hardware	20.12
Incidentals	26.32
	$737.00

A row of cows stands on each side of the center drive way and facing away from it. Most of the cows are confined in what are called Bidwell stalls, a style of cow stall patented by Porter Bidwell of McGregor, Iowa. In this stall, as built in this barn, the cow is not tied but is kept in place by a partition on each side high enough to prevent her attempting to jump over it, by a fence in front also high enough to prevent any attempt to escape in that direction, and finally by a chain or rope stretched across behind just above the gambrel joints which prevents the cow from backing out. The width of the stall is so adjusted to the size of the cow that she does not attempt to turn around. Twenty of the stalls in the new barn are three feet and two inches wide. To test the matter eight others are made three feet and four inches wide, but three feet and two inches is wide enough for even large Holstein or Shorthorn cows. The length of

the stall is adjusted to the size of the cow by moving forward or back the manger to which is attached the fence across the stall in front of the cow. When the cow is put in the stall this manger is crowded back just far enough to allow her head free movement when her hind feet stand on the very edge of the gutter. To be efficient a stall must keep the cow both comfortable and clean. By allowing free movement of the head and limbs and by permitting the use of sufficient bedding this style of stall allows the maximum of comfort, and since the cow is compelled to stand with her hind feet at the edge of the gutter, cleanliness is assured. The fact that a foul udder is practically never found is sufficient evidence of the efficiency of the stall in this respect.

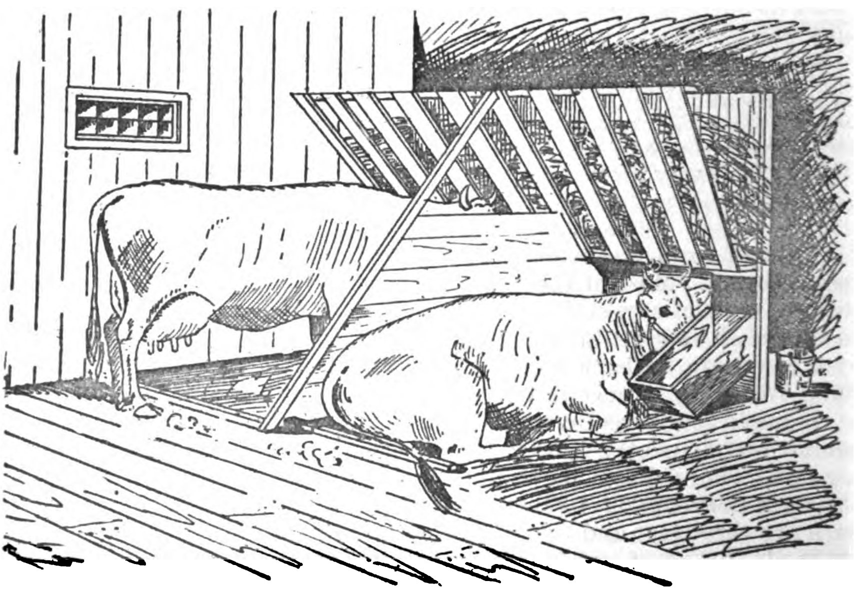
The Hoard Stall.—A second form of stall used in the new barn is called the Hoard stall. It is unpatented and simple in construction. It is described as follows by its inventor, Ex-Governor W. D. Hoard of Wisconsin, in Hoard's Dairyman, of June 23, 1893, page 284:

"The excellence of this plan of tying cows, over the stanchion plan is found as follows:

"(1) The cow has three and one-half feet in width of stall and perfect liberty and comfort of position.

"(2) By virtue of the bar across the stall floor, which will be seen just forward of the hind feet of the standing cow, the animal has always a dry, clean bed to lie in, thus keeping her as clean from manure in winter as though she was in a June pasture.

"(3) By this system each cow is protected when lying down from having her teats and udder stepped on by her standing neighbor. This is one of the most productive sources of injury that is known, and of itself should condemn the rigid stanchion."



"The cut represents one row of cows facing another row. A closely boarded partition about four feet high forms the front of the stall. Each cow has three and one-half feet in width. The floor is made tight and there is no drop in rear of cows, except the thickness of one plank, which is the double floor of the stall. The feeding rack is constructed for two purposes; 1. To contain any hay or roughage that may be fed the cow. The slats are put on wide enough so the cow can easily get her nose between them. 2. To force the cow when standing to stand with her hind feet in rear of the cross bar across the stall floor. In constructing the feeding rack nail a 2x8 piece of scantling edgewise, against the board partition. This constitutes the bottom of the rack and should be placed about 30 inches from the floor. Place the top scantling about two feet from the partition. This makes the feeding rack eight inches wide at the bottom and two feet wide at the top. In the center of the bottom scantling fasten a ring screw to tie the halter to. Fasten the cow with a common web halter, she wearing the head piece all the time; the halter end of the rope has a safety snap to fasten into the ring of the halter under the throat. To prevent the cow from getting loose it is well to divide the end of the rope into two strands each six inches long and put a snap in each, fastening in both, the ring when tying the cow.

"The grain and ensilage box is placed on that side of the stall opposite to the one the cow usually lies on. If she lies on her left side place the grain box on the right side, as seen in the engraving. This box is large enough to contain the ensilage and grain feed, and is reached by an opening in the partition. It is best to have the feed box slant down towards the cow, so that all the feed will easily work down to the end nearest her. This box should be long enough to extend from the partition into the stall as far as the upper part of the feed rack projects and about 18 or 20 inches wide and 16 inches deep. If placed sufficiently slanting, the feed will easily work down to the lower end next the cow, so that she will not need to bring her hind feet in on her bedding, in order to reach the contents of the box.

"In placing the bar across the stall bring the cow's head squarely up against the feeding rack; then just forward of her hind feet nail down a 2x3 scantling. Fill the space forward of the bar with bedding, which being without waste will last till entirely worn out. In this way each cow has her bed in true proportion to her length. It should be made fresh once a week, however, for the sake of health. We commend this stall to all dairymen who are looking for a clean, comfortable method of stabling dairy cows."

BULLETIN 150 **DECEMBER, 1897**

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

SUGAR BEETS IN MICHIGAN IN 1897

By C. D. SMITH and R. C. KEDZIE

AGRICULTURAL COLLEGE, MICHIGAN
1897

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Special Spraying Bulletin—When and What to Spray.

I. H. BUTTERFIELD,
Secretary.

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OF THE EXPERIMENT STATION

AGRICULTURAL COLLEGE, MICH.

1897

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.

BULLETIN 150 **DECEMBER, 1897**

SUGAR BEETS IN MICHIGAN IN 1897.

BY C. D. SMITH, DIRECTOR, AND R. C. KEDZIE, CHEMIST.

INTRODUCTION.

The effort to supply our people from the products of our own soil with so necessary a food material as sugar, now largely imported from other countries, cannot fail to be a matter of deep interest to every person interested in the welfare of the State. Why this country should, year after year, send abroad $100,000,000 in gold to pay for a crop that can be successfully raised on our own soil and manufactured by our own people, has never been satisfactorily answered. The hesitancy to embark in sugar making has hinged upon the question whether our soil and climate are capable of producing sugar beets fit for the factory. It is mainly to settle this question, so far as Michigan is concerned, that the present investigation has been undertaken. The recent legislation in our State offering a bounty on sugar made from beets grown in this State has awakened additional interest among our farmers.

DIVERSIFIED INDUSTRY.

In times of industrial depression, such as the one through which we have lately passed, what the country especially needs is diversified industry, so that the glut of one product shall not cause a stagnation of others. This is especially true in agriculture. In the northern states the three cash crops have been wheat, meat and wool; but wheat has led the industrial race, and the price of wheat has been the business barometer for farmers. The introduction of a new "cash crop" to diversify the old system of rotation, and stop the impoverishing tendency of continuous exportation of grain, is full of promise to the farmer, and gives tokens of prosperity to the business public.

The Honorable Secretary of Agriculture, with an eye that takes in the whole sweep of industrial pursuits, has given a powerful impulse to this industry of national importance. By freely furnishing beet seed of the highest quality to such sections of the country as appear to be

adapted to this crop, and by inviting the cooperation of the Experiment Stations in this work, he has done much to bring this new industry into prominence in all the northwestern states.

CLIMATIC CONDITIONS FOR SUGAR BEETS.

For growing most crops, the weather is even more important than the soil. The conditions of climate best suited to growing the sugar beet differ from that of many crops, and the weather that would seriously impair the production in other crops, may be well suited to the crop of beets with a large content of sugar. In Germany, it has been found that a certain average temperature for the several months from May to November, and a certain average rainfall during these several months, are best adapted to the growing of this crop. Such a "sugar beet belt" sweeps through the lower peninsula of Michigan.

Beyond most crops, the sugar beet is less liable to be injured by the variations in weather occurring in our State. It is not a tender plant and will not be injured by spring frosts that would kill Indian corn. It may, therefore, be safely planted in the spring many days before anyone would think of planting corn, and it will grow and ripen in the fall for weeks after the corn is killed by frost. It is practicable to plant the beets early in the spring and get them well established, rooted, and grounded in the soil during our season of abundant moisture, from May to July. When thus established in a well prepared soil, properly thinned from eight to ten inches in the row, kept free from robber weeds, and given proper cultivation to secure the mulch of a thin layer of porous soil, the beets can withstand "the August drought," and thrive and grow when the corn leaves roll for want of rain, and they will continue to grow and sweeten under the Indian summer sun long after potatoes and vines have shriveled under the frosts.

The beet can thrive in the hot and dry weather of mid-summer because of its root distribution in porous soils, the tap root passing down into the subsoil and drawing its supply of water and plant food from these deep recesses. If the plant is nourished by the surface soil till it can tap the subsoil it may thrive in weather that would burn up the surface feeding plants.

Our German consul, Julius Muth, under date of June 3, 1897, writes from the heart of the beet sugar district: "A rich, deep soil, with a porous, well drained subsoil, should be selected. If the climatic conditions are such that the beets are assured of abundant moisture for the first three months, then a limited amount of moisture and dry, sunny weather, for the last thirty days, such lands are well adapted for the cultivation of the sugar beets. It is of great importance that the last thirty days be dry and sunny; wet weather at this period will start a second growth in the beets at the expense of the saccharine contents."—Consular Reports, Aug., 1897.

In a few localities in this State the trial with sugar beets is reported as a failure on account of dry weather, "Not one seed in a thousand grew at all." If the climatic conditions in any locality are too precarious, it would be folly to attempt the cultivation of sugar beets.

THE SOIL.

Certain conditions of soil, both in chemical composition and texture, are best suited to the development of the sugar beet. The plant requires a good supply of potash and phosphates, but its quality is injured by excess of organic matter and nitrates, causing a decrease of sugar and an increase of gum-like or non-saccharine matter, lowering the coefficient of purity. Mucky lands and soils containing an excess of vegetable matter are not suitable for raising sugar beets. In spite of many warnings on this point, many farmers have persisted in planting their sugar beets on muck, with the result of lowering the record for sugar beets in their county and the records for the State at large—in the latter case a reduction of nearly one-half per cent. There can be no objection to farmers planting all the sugar beets on muck they may choose, but they should not offer them as sugar beets for making beet sugar. They are good for fodder and good for nothing else.

The texture of the soil is of great importance. The body of the beet should be entirely covered by the soil, only the crown and leaves appearing above it. No part of the beet that grows above the soil is of value in making sugar. To have the beets thus grow within the soil, the latter must be open and porous, and the subsoil in particular must be penetrable by the tap root as it goes down in search for mineral food and especially for water in the season of surface dryness. This last condition is often not sufficiently considered in preparing a field for sugar beets. The tap root penetrates the soil to a surprising depth if the subsoil is porous, and draws most of the supply of moisture for the plant from the subsoil. If there is enough rain in May, June and July to get the tap root well established on its exploring trip for food and moisture, and the subsoil is open so that the roots freely penetrate the deeper soil, then the "August drought" does not retard the growth of the beet, and the bright sunshine of August, September and October packs the beets full of sugar. But to carry forward this process of saccharine accumulation during such "dry spells," the plant must draw upon the deep vaults of our bank of earth by the tap root reaching the water of the subsoil. Such results can be secured only when the subsoil is penetrable by the beet root. Hence the need of very deep cultivation and of subsoiling by the plow to break up any hard pan. It is also evident that the tap root should not be broken, and this explains why transplanting is often a failure, unless done with care.

An open soil—a loam, sandy loam, clay loam, sandy soil, or gravelly soil—with a penetrable subsoil, is the ideal for growing sugar beets. A stiff clay with a hard pan is the most difficult to manage; and the muck beds are to be rejected entirely.

THE KIND OF BEETS.

The beet now used for making sugar is a highly developed plant, and has been secured as the result of careful cultivation and selection for a long period. When Margraff of Austria announced, one hundred and fifty years ago, the presence of cane sugar in the White Silesian beet in such quantities that sugar could be manufactured from this beet,

it only contained from six to seven per cent of sugar. This White Silesian seems to have been the parent of all the sugar beets now in cultivation, and by careful training varieties have been secured containing nearly three times the amount of sugar found in the original beet. Many kinds of beets are in the market that are called sugar beets which are very far from the highly developed and specialized sugar beets required for manufacturing purposes. It should be borne in mind that many so-called "sugar beets" will not profitably make beet sugar.

Some mistakes have been made by Michigan farmers this season by planting seeds that were not true sugar beets. Beets have been sent to the College for analysis that were red, pink or orange in color, whereas the real sugar beet is white, and roots of other colors show either a different variety of beet or a degenerate seed. Mangel wurzels of large size have been sent as specimens of sugar beets.

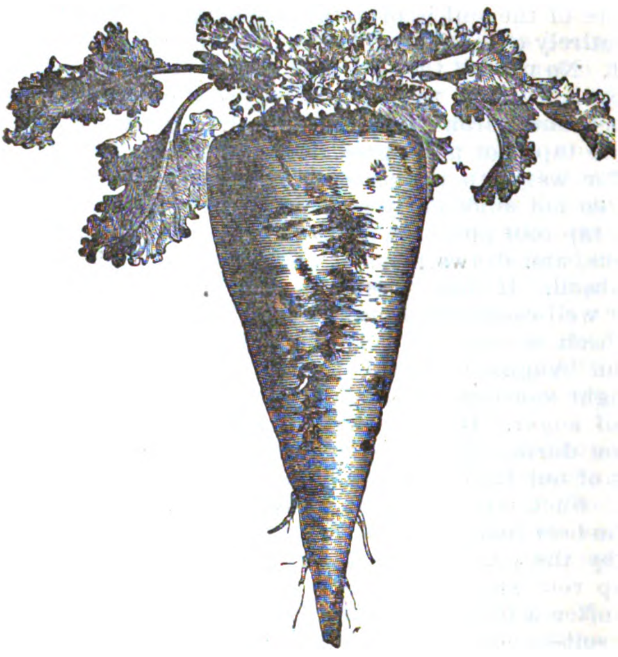


Fig. 1.—Kleinwanzlebener Sugar Beet, Wiley, Farmers' Bulletin 52, United States Department of Agriculture.

To guard against such mistakes, the Experiment Station required the name of the variety of beet used in the experiment. Another object to be secured in knowing the name of the beet in each experiment is to find what kind of beets will give the largest product of sugar and the largest average yield of beets on any kind of soil, or in any district. This information will be of value to the farmer and also to the manufacturer. The Station tries to gather valuable information, not simply to gratify curiosity, and hence has insisted on the name of the beet.

We have two kinds of sugar beets of such uniform excellence, and character so fixed by long cultivation, that it would seem unnecessary for the farmer to use other kinds in experimental trials. First in this class is the well known German beet, Kleinwanzlebener. Three varieties of this beet have been raised on the College farm this year, and a cut kindly furnished by the Department of Agriculture, at Washington, D. C. (Fig. 1), fairly represents a typical specimen of one of them.

The typical form of the sugar beet is a slim cone, well covered by the soil during growth, and with fine, hair-like roots given off from opposite sides.

Fig. 2.—White Improved Vilmorin Sugar Beet, Wiley, Farmers' Bulletin 52, United States Department of Agriculture.

The other beet is the Vilmorin (Fig. 3), the favorite sugar beet in France. This is a beet of high quality for manufacturing purposes. In comparing these two varieties of beets with each other, a slight difference is found in favor of the Vilmorin, the average per cent of sugar in 1897 in three hundred and thirty-one samples of Kleinwanzlebener was 16.40, and in 81 samples of Vilmorin was 16.50, showing an average difference of only one-tenth of a per cent this year. In the trials in 1891, the season being less favorable for sugar beet production, fifty-eight samples of Kleinwanzlebener showed an average percentage of sugar of 13.86, while forty-six samples of Vilmorin showed 14.22, a difference of thirty-six hundredths of a per cent in favor of the Vilmorin. The differences in the coefficient of purity between the two varieties in the two years were equally trifling. No one will make a serious mistake by planting either of these sugar beets.

A cut of another sugar beet that is attracting much notice, the Le Plus Riche is here inserted. It has a fine form, and is a vigorous grower. Samples of this beet grown on the College farm this year showed 18.78 per cent of sugar. It seemed to be a beet of good promise and appropriately called The Very Rich.

Fig. 3.—White French Rich Sugar Beet, Wiley, Farmers' Bulletin No. 52, United States Department of Agriculture.

PAST WORK OF THE STATION.

The Station has already published two bulletins on subjects relating to the growing of sugar beets and the adaptation of the soil and climate of Michigan to the crop. Both bulletins were issued by the Chemical Department. Bulletin 71, sent out in February, 1891, after

showing by charts that the climate of Michigan was as well adapted to sugar beet growing as that of Halle, in Germany, and Cambrai, in France, gave full directions, first for the selection of suitable plots in which to grow experimental areas of the roots, and secondly for the cultivation and harvesting of the crop.

In Bulletin 82, the results of the investigation carried on by the Station in the season of 1891 are set forth. Sixteen hundred pounds of selected seed were imported from France and distributed in large or small packages to any one who applied and promised to plant the seed and cultivate the beets according to the printed directions, and to furnish a report of the results of the trial, with sample beets for analysis, to the Station at the end of the season. Seed was sent to nearly four hundred persons with full directions for planting and cultivating and a form for the report. Two hundred and twenty-eight samples were analyzed and the reports given in the bulletin. The weather for the season of 1891 was characterized by a warm and dry April and May, a cool June, a very cold and dry July, a cold August with plenty of rain, and a warm September. The heat and cold were badly distributed for the beet crop, which suffered also from the unusually prolonged midsummer drouth. As a result the records show variations in per cent of sugar from 13.14 to 16.09, and in coefficient of purity from 71 to 98.5, but averaging not far from 80. The reported yields per acre were from 13.5 to 15 tons.

Considering the character of the season and the complete inexperience of the farmers, the results were far from discouraging.

INVESTIGATIONS IN 1897.

In March, 1897, five hundred pounds of sugar beet seed were received from the Department of Agriculture, Washington, D. C., and late in April a second consignment of two hundred pounds from the same source arrived for distribution. The Station was charged with the duty of trying such experiments on the home grounds as were deemed wise and most helpful to a decision of the questions relating to the adaptability of the soils and climate of Michigan to the production of sugar beets rich in sugar, and with the farther duty of distributing the beet seed, received from the department, to such farmers as would plant and care for the crop as directed by the officers of the Station and would later send in representative beets for analysis, accompanied by a full report of the essential facts of the cultivation and yields.

The report of the work of the season divides itself naturally into two parts, experiments at the Station and tests made by the farmers throughout the State.

EXPERIMENTS AT THE STATION.

Plots. Four one acre plots were selected for the sugar beet experiments on the level, well drained tract of sandy loam in the western half of Field 6, of the College farm. These acre plots are thirty-six rods north and south by seventy-three and one-third feet east and west. Plot 8,

the one of the series farthest west, was plowed and subsoiled April 17. The plowing was done with an ordinary hand plow, which was followed immediately by a subsoil plow (Fig. 4), which loosened the ground to a depth of sixteen inches. The hand plow cut a furrow twelve inches wide and eight inches deep. The subsoil plow loosened the soil eight to ten inches below the bottom of the furrow made by the hand plow, but did not move it from its place. The next furrow of the hand plow covered this loosened dirt without mixing the soil and subsoil.

The field had been in corn the year before, planted on an inverted timothy sod which had been covered with a heavy coat of manure in the fall of 1895. The field had been a meadow for the years 1893, 1894 and 1895.

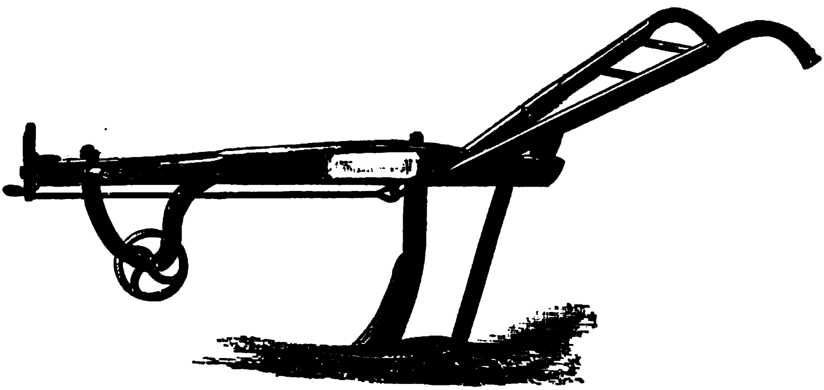


Fig. 4.—Subsoil Plow, Wiley, Farmers' Bulletin No. 52, United States Department of Agriculture.

Plots 9, 10, 11 and 12, lying parallel to Plot 8 and adjacent to it on the east, were plowed and subsoiled on April 19 and 20. The amount of time spent in plowing and subsoiling these plots was six hours with two men and two teams, or twelve hours for one man and team, per plot. Rain fell almost continuously from April 22 to May 5. On May 7, the plots were harrowed thoroughly with a spring tooth harrow and later with a lighter slanting tooth harrow, until the ground was in as fine tilth as could be desired for an ideal garden. It was then marked in rows twenty-two inches apart and perfectly straight. On May 8, the beet seed was planted with a Planet Jr. garden drill (Fig. 5) as follows:

Plot 8, west eighteen rows, 6¼ lbs., Wohanka seed.
Plot 8, next twenty-two rows, 7¼ lbs., Kleinwanzlebener.
Plot 9, west thirty rows, 9.8 lbs., Original Kleinwanzlebener.
Plot 9, next ten rows, 3.5 lbs., Government Kleinwanzlebener.
Plot 10, west thirty-two rows, 9 lbs., Vilmorin's Improved La Plus Riche.
Plot 10, remaining eight rows, 4 lbs., Government Kleinwanzlebener.
Plot 11, forty rows, 13.7 lbs., Government Kleinwanzlebener.

Between thirteen and fourteen pounds of seed per acre were used that there might be no breaks or vacant spaces in the rows. It has been found difficult, if not impossible, to successfully transplant beets to fill up gaps. Experience in sections where the industry has been pursued for several years has demonstrated that it is much more economical to sow the seed thick at the outset and remove all surplus beets at the time of thinning, when the beets are showing the fourth leaf, than to attempt to save seed by thinner sowing.

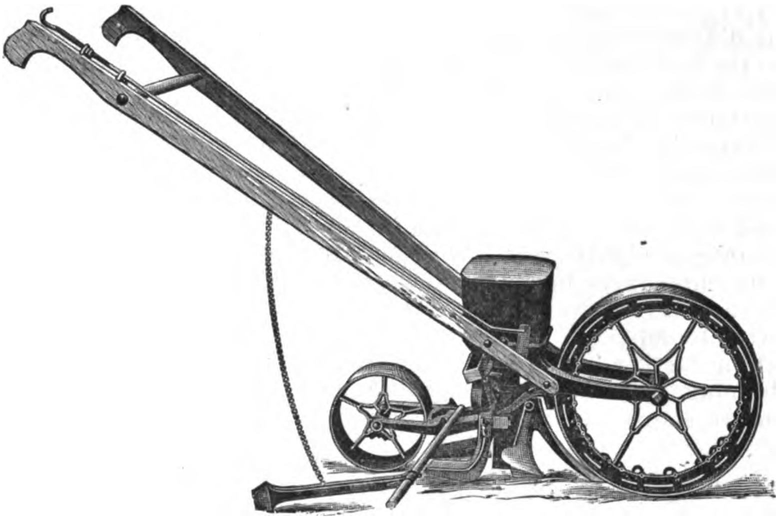


Fig. 5.—Planet Jr, Garden Drill, Wiley, Farmers' Bulletin No. 52, United States Department of Agriculture.

Cultivation began May 17, before the plants had appeared above the surface of the ground. All the plots were gone over at that time with a Breed's weeder, which served the double purpose of killing the germinating weeds and stirring up the soft, shallow mulch needed to prevent the escape of moisture.

On the first of June all plots were cultivated with Planet Jr., one-horse cultivators. This cultivation was repeated June 12 and June 21. By the latter date the beets were showing the fourth leaf with roots as large as a wheat straw. The thinning was therefore done immediately after the cultivation June 21. By means of a sharp hoe, a large share of the surplus beets were removed from each row, leaving bunches of plants eight or nine inches apart from center to center. Men and boys followed on their knees and removed from these bunches all but the strongest plants. In this way, after the thinning, there was on the average one beet every eight inches in the row, and the rows were twenty-two inches apart. To leave the beets closer together is to grow too small roots. To thin them to a greater distance apart is to invite

the growth of large specimens with a low per cent of sugar. Thinning by hand is an arduous and extremely disagreeable undertaking, but under present conditions is absolutely necessary. Nothing has been invented that can take the place of the human eye and the human hand in selecting from a thickly growing bunch of beets the strong plant to be left growing.

The time spent in thinning the four acre plots was as follows:

Plot 8—85.5 hours.
Plot 9—81.5 hours.
Plot 10—70.0 hours.
Plot 11—86.0 hours.

This difference in the time required to thin and weed the beets was due to the fact that Plots 8 and 11 were much worse infested with grass and weeds than the other two acres.

A half acre of sugar beets grown by Bert Cook of Owosso, Mich., on a fall plowed clay loam, following oats in '96, corn in '95, and clover in '94, with the ground thoroughly fitted with a cutaway harrow, followed by an Acme, and cultivated with a Breed's weeder twice before thinning, required forty-four hours labor to do the thinning for the half acre, or at the rate of eighty-eight hours per acre.

No attempts were made to fill up gaps by transplanting as the seed had been evenly scattered and few gaps longer than eight inches to a foot were found.

Nothing farther in the way of cultivation was done to the crop after the thinning. The mean temperature and rainfall by weeks during the season are shown in the following table:

Mean Weekly Temperature and Weekly Rainfall from May 1, to October 22, 1897.

Week ending	Mean temperature.	Rainfall. In.
May 7	51	1.45
May 14	65	.23
May 21	60	1.07
May 28	54	.45
June 4	56	.53
June 11	59	.69
June 18	70	1.10
June 25	66	.06
July 2	72	.80
July 9	82	.00
July 16	69	2.61
July 23	72	1.24
July 30	72	4.84
August 6	71	.86
August 13	71	.23
August 20	68	.46
August 27	65	.10
September 3	65	.56
September 10	74	.00
September 17	69	.85
September 24	56	.00
October 1	58	.00
October 8	57	.16
October 15	58	1.23
October 22	51	.61

The season was unusually cool and wet. July was so very wet that it was impossible to get on the beet field with a cultivator. In August, the showers were fairly well distributed and the crop suffered from no lack of moisture. September was warm with almost continuous sunshine, giving just the conditions required to develop the sugar in the beets. The second week in October was wet and the days following warm and murky. It was necessary therefore to harvest the beets at once to prevent a second growth and a consequent lessening of the per cent of sugar.

The deep preparation of the ground and subsequent thorough cultivation up to the time of thinning had left the soil in such fine tilth that the beets grew well below the surface as shown in the annexed cut (Fig. 6). The importance of this matter of having the soil soft and porous to a

Fig. 6.—Correct position of a mature beet in the soil. Wiley, Farmers' Bulletin, 52, United States Department of Agriculture.

good depth cannot be exaggerated. In some parts of the plots the hard subsoil was not thoroughly broken up by the subsoil plow. In these places the beets, instead of having the desired long conical form, were short and almost spherical in general contour, with large branching roots. Such beets would not be received by a factory, and would therefore be worthless in the hands of the farmer growing the crop for sugar making purposes.

The beets were harvested October 16. A plow was run alongside each row and close to it, throwing the soil away and leaving the beets stand-

ing on the very edge of the furrow. The beets were then pulled by hand, the tops wrenched off and the roots thrown in piles, which were weighed and hauled to the pit to be stored for winter feeding. Owing to the deep subsoiling and thorough preparation of the ground, the roots were found to have grown almost entirely covered with soil, the tops alone above the surface. Few beets exceeded three pounds in weight and the bulk of the crop averaged not far from two and one-half pounds. The time required for harvesting was, per acre, 4.6 hours for man and team, and 130.75 hours for a man.

The total amount of labor expended on the beets is summed up in the following table, which gives separately the hours of team and hand work per acre:

	Man and team. Hours.	Man. Hours.
Plowing and subsoiling	12.	
Harrowing	3.75	
Marking	.8	
Planting		3.25
Cultivating	15.	
Thinning and hoeing		75.90
Harvesting	4.60	130.75
Total time per acre	36.15	209.90

The hand labor in harvesting was performed by boys at eight cents an hour. The 79.15 hours spent in hoeing and thinning was done by men at twelve and one-half cents an hour. The team work is reckoned at twenty-five cents an hour for man and team. At these prices the cost of labor for growing an acre of beets was $29.40.

The yield of the beets by varieties and by acre plots was as follows:

	Pounds
Plot 8, Wohanka, .45 acre	10,627
" " Kleinwanzlebener Improved, .55 acre	14,123
Total for Plot 8	24,750
Plot 9, Original Kleinwanzlebener, .75 acre	20,523
" " Government Kleinwanzlebener, .25 acre	6,412
Total for Plot 9	26,935
Plot 10, La Plus Riche, .80 acre	23,364
" " Government Kleinwanzlebener, .20 acre	5,904
Total for Plot 10	29,268
Plot 11, Government Kleinwanzlebener, 1 acre	32,327

Average yield per acre, 28,328 pounds.

Below is given the average yield per acre by varieties, with the per cent of sugar and the coefficient of purity:

Variety.	Yield per acre, pounds.	Per cent sugar.	Purity.
Wohanka	23,615	15.22	86
Improved Kleinwanzlebener	25,678	16.40	91
Original Kleinwanzlebener	27,368	18.27	94
Government Kleinwanzlebener	25,648	17.78	94
La Plus Riche	29,305	18.78	93
Government Kleinwanzlebener	23,327	17.78	94
Hoerning's Improved	24,500	15.20	89
Floto's Improved	20,200	13.21	88
Kleinwanzlebener on muck	----------	12.96	75

Hoerning's Improved Kleinwanzlebener seed was received from Edmund Stark, Grand Island, Neb., and was sown on Plot 12, the acre east of Plot 11 and adjacent to it. The seed arrived late and was sown May 18 and 22.

The Floto's Improved Beet seed was donated to the Station by the Wernich Seed Co., Milwaukee, Wis., arrived late, and was sown May 22, in rows parallel to the acre plots and east of them 12 rods.

Experiments were planned to test the relative values of commercial fertilizers and of certain mineral salts on the growth of sugar beets, but the crop was so badly injured by a fungus disease (*Cercospora beticola*) as to invalidate the results. The addition of mineral manures did in general increase the yield, but accurate results cannot be given because of the invasion of this disease.

REPORTS OF EXPERIMENTS MADE BY FARMERS AND RESULTS OF ANALYSES OF THE SUGAR BEETS.

On the receipt of notice from the Department at Washington that sugar beet seed was to be sent to the station for distribution, letters were written to a large number of farmers, several in nearly all of the counties of the lower peninsula, explaining the nature of the proposed experiments and asking cooperation in the solution of the questions relating to the quantity and quality of sugar beets that Michigan could produce. Four hundred and sixty-six separate shipments of seed were made. A single shipment went often to several farmers, there being the names of four hundred and eighty-nine farmers on the list of those who received seed from the Station. To several places, notably Saginaw, Port Huron, Sand Beach, and a few others, amounts of seed were sent in bulk and distributed by persons appointed for that purpose by the Station.

From time to time during the season special bulletins were issued and sent to the beet growers outlining the correct methods of planting, caring for and harvesting the crop. By private letters, by special publications and by articles in the newspapers, the officers of the Station called atten-

tion to the necessity of thorough preparation of the ground, of thick sowing, of early and frequent cultivation, of thinning at the right time and in the right way, and finally to the method of harvesting to insure an accurate report of the results to the Station.

Four hundred and eighty-four samples have been sent to the Station for analysis from points outside of the College farm. The available results from these samples and reports of the experimenters, together with the results of the analyses of the beets are presented in the following table, giving by counties the name and residence of each experimenter with as full a report of the conditions of the experiment as the Station could procure, and the results of the analysis of each sample.

This table is given to the public in the hope that it will be of interest and benefit to the people of our State, and especially to those localities where the samples were raised. The table does not include the report of all the samples sent to the Station. Some have been omitted because the precise points which chiefly gave valuable information to the public were omitted, when sending the samples. This information was solicited often by a personal letter sent out after the receipt of the beets, yet was not furnished. Other reports have been omitted either because the beets were sent without the name or residence of the experimenter, or because the beets sent were dried and shriveled, and on that account no fair conclusion as to their value could be drawn from the analysis. With these exceptions, every sample of sugar beets sent to the Station has been analyzed and reported.

In the table there is included the report of the analyses of the sugar beets grown on the Station farm. Reports of analysis have not been sent, to the persons forwarding beets, prior to the publication of this bulletin, because of the pressure of other duties on Station officers. The work has been pushed as rapidly as possible to let all parties know of the outcome of the experiment.

Results of cultivation of sugar beets in Michigan in 1897, with reports from experimenters and results of analysis of the sugar beets.

Lab. No.	Name.	Locality.	Variety of sugar beet.	Kind of soil.	Average weight of the beets in ounces.	Tons per acre.	Per cent. of sugar.	Purity.
1	Higgins & Lenders, 823B	Saginaw	Kleinwanzlebener	Muck	48	....	8.81	72
2	" " " 97A	"	Vilmorin	Sandy loam	30	24	17.07	89
3	" " " 60A	"	Kleinwanzlebener	Clay loam	40	34	17.13	84
4	" " " 90A	"	"	Sandy clay	24	37	18.07	93
5	" " " 572	"	Wohanka	Sandy loam	19	90	16.54	86
6	" " " 458A	"	Kleinwanzlebener, Original	Black loam	34	82⅓	17.49	83
7	" " " 498B	"	"	Sandy	26	10	18.06	93
8	" " " 573	"	"	Clay loam	20	26	15.00	81
9	" " " 482A	"	Vilmorin	Sandy loam	29	26	15.03	87
10	" " " 575	"	Kleinwanzlebener	" "	19	40	12.07	85
11	" " " 577	"	"	" "	19	32½	18.44	81
12	" " " 579	"	Wohanka Extrareichen	Sandy	16	63⅓	13.58	80
13	" " " 576	"	Wohanka	Sandy loam	27	90	17.07	85
14	" " " 579	"	Kleinwanzlebener	" "	29	63⅓	14.86	81
15	" " " 374B	"	"	Sandy	43	87¾	16.54	89
16	" " " 578	"	Wohanka	"	19	81⅓	13.99	81
17	" " " 574	"	Kleinwanzlebener	Sandy loam	34	94	15.85	86
18	" " " 90B	"	"	Sandy clay	20	88	18.06	88
19	" " " 53B	"	"	Clay loam	24	34	14.74	86
20	" " " 286A	"	"	Black clay	16	31	16.11	87
21	" " " 105A	"	Vilmorin	Sandy clay	20	....	14.57	80
22	" " " 122B	"	Kleinwanzlebener, Original	Sandy loam	30	22⅓	16.73	88
23	" " " 339A	"	Vilmorin	" "	22	23	15.90	87
24	" " " 493B	"	"	" "	24	26	16.42	89
25	" " " 363A	"	Kleinwanzlebener	Clay	30	37	13.30	80
26	" " " 115B	"	Vilmorin	"	36	....	17.58	87
27	" " " 373B	"	"	Sandy loam	33	24	16.31	84
28	" " " 17A	"	Kleinwanzlebener		21	40	16.03	86
29	" " " 78A	"	Vilmorin		30	35	18.07	86
30	" " " 286B	"	Kleinwanzlebener	Clay loam	18	31	16.51	89
31	" " " 116B	"	"	" "	24	....	16.05	87
32	" " " 458B	"	" Original	Black loam	31	....	13.81	87
33	" " " 57A	"	"	Yellow clay	28	20⅓	16.03	80
34	" " " 196A	"	Vilmorin	Black loam	23	33½	11.87	74
35	" " " 115B	"	"	Clay and sandy loam	28	52⅓	15.90	86
36	" " " 332	"	Kleinwanzlebener	Sandy loam and muck	31	....	14.42	79
37	" " " 210A	"	"	Sandy	30	56	13.47	79
38	" " " 562B	"	Vilmorin	Clay	32	37	16.05	84
39	" " " 73A	"	Kleinwanzlebener	"	31	33⅓	13.99	80

Results of cultivation of sugar beets in Michigan in 1897, with reports from experimenters and results of analysis of the sugar beets.

Lab. No.	Name.	Locality.	Variety of sugar beet.	Kind of soil.	Average weight of the beets in ounces.	Tons per acre.	Per cent. of sugar.	Purity.
40	Higgins & Lenders, 496A	Saginaw	Kleinwanzlebener	Sandy	37	23	16.99	84
41	" " " 562A	"	Vilmorin	Clay loam	30	30½	18.44	76
42	" " " 482B	"	Kleinwanzlebener	Clay and sand	40	....	16.54	84
43	" " " 569A	"	Vilmorin	Black sand	23	22½	16.67	80
44	" " " 192B	"	Kleinwanzlebener	Black sandy loam	25	23½	17.05	88
45	" " " 389A	"	"	Very poor	37	24	15.75	83
46	" " " 248B	"	"	Blue clay	34	23	17.07	82
47	" " " 199A	"	Vilmorin	Sandy loam	23	30	15.13	88
48	" " " 502A	"	Kleinwanzlebener	Clay loam	26	29	14.16	83
49	" " " 105B	"	Vilmorin	" "	25	18½	17.32	86
50	" " " 244B	"	Kleinwanzlebener	" "	34	19	18.02	80
51	" " " 210B	"	"	Sandy	16	20½	14.62	80
52	" " " 327B	"	Vilmorin	Black sand	40	40	16.02	90
53	" " " 3A	"	Kleinwanzlebener	Sand and clay	24	35	17.07	88
54	" " " 249A	"	"	Clay loam	32	18½	15.96	81
55	" " " 69B	"	"	Sandy loam	30	45	17.60	85
56	" " " 506B	"	"	Black sand	26	20	15.13	84
57	" " " 192A	"	"	" "	25	40	15.35	87
58	" " " 523B	"	"	Black sandy soil	19	18½	18.05	88
59	" " " 375A	"	"	Sandy loam	36	24	16.31	86
60	" " " 237B	"	Vilmorin	Mixed ground	20	31	17.49	86
61	" " " 501	"	Kleinwanzlebener	Clay loam	23	18½	19.15	86
62	" " " 3B	"	"	Sand and clay	31	35	16.03	80
63	" " " 497B	"	"	Sandy loam	44	29	15.35	85
64	" " " 248	"	"	Blue clay	24	23	18.83	87
65	" " " 46B	"	"	Sandy loam	21	22½	15.85	84
66	" " " 71	"	"	Sand and clay	32	20	16.67	85
67	" " " 35	"	"	Clay loam	25	16½	17.38	84
68	" " " 93B	"	Vilmorin	" "	20	71½?	22.83	91
69	" " " 249	"	Kleinwanzlebener	Clay	28	18½	15.37	86
70	" " " 288A	"	"	Hard clay	20	23½	14.94	79
71	" " " 122A	"	" Original	Sandy loam	21	21½	17.43	88
72	" " " 340B	"	Vilmorin	Dark loam	39	21	16.56	84
73	" " " 523	"	Kleinwanzlebener	Black sand	35	18½	14.42	84
74	" " " 3	"	"		38	35	18.82	86
75	" " " 531	"	"	Sandy	26	37	17.24	82
76	" " " 57B	"	"	Yellow clay	37	20	16.11	83
77	" " " 337	"	"	Sandy	30	25½	17.49	85
78	" " " 293	"	"	"	28	12½	10.31	78

79	" " "	569B	"	Vilmorin	Black sand	19	37¾	18.94	92
80	" " "	25B	"	"	Black loam	24	10¾	20.98	89
81	" " "	60B	"	Kleinwanzlebener	Clay loam	33	34	17.33	82
82	" " "	97B	"	Vilmorin	Sandy loam	33	24	17.05	83
83	" " "	116A	"	Kleinwanzlebener	Clay loam	37	33½	16.22	85
84	" " "	120A	"	Vilmorin	Sandy loam	30	18¾	16.03	81
85	" " "	90	"	Kleinwanzlebener	" "	20	33	19.58	83
86	" " "	120B	"	Vilmorin	" "	27	18¾	20.18	88
87	" " "	322B	"	Kleinwanzlebener	Muck	40	18½	10.54	75
88	" " "	288A	"	"	Hard clay	23	23½	14.16	75
89	" " "	33A	"	"	Clay loam	35	34	18.30	86
90	" " "	198B	"	Vilmorin	Black loam	32	33½	18.72	76
91	" " "	8A	"	Kleinwanzlebener	Sandy	35	30	21.22	90
92	" " "	199B	"	Vilmorin	Sandy loam	21	30	16.62	89
93	" " "	23A	"	"	Clay	31	39¾	18.58	80
94	" " "	363B	"	Kleinwanzlebener	"	28	......	15.25	83
95	" " "	507B	"	"	Black muck	28	25¾	14.31	75
96	" " "	497A	"	"	Sandy	30	29	15.90	86
97	" " "	298A	"	"	Sandy loam	20	12½	11.27	70
98	" " "	298B	"	"	" "	20	12¾	17.30	85
99	" " "	93	"	Vilmorin	Clay loam	20	71½?	19.99	88
100	" " "	565	"	Kleinwanzlebener	......	22	......	16.19	86
101	" " "	457	"	"	......	33	39	12.75	77
102	" " "	507B	"	"	Muck	23	25¾	18.30	83
103	" " "	69	"	"	Sandy loam	24	45	14.94	79
104	" " "	559B	"	Vilmorin	" "	25	25	17.07	83
105	" " "	581D	"	"	Loose and mellow	23	27	20.93	88
106	" " "	559B	"	"	Sandy loam	24	25	15.85	87
107	" " "	23B	"	"	Clay soil	33	40	11.87	70
108	" " "	210A	"	Kleinwanzlebener	Sandy	22	56 ?	15.35	87
109	" " "	339B	"	Vilmorin	Sandy loam	20	28	16.81	83
110	" " "	8B	"	Kleinwanzlebener	Sandy	35	30	18.18	88
111	" " "	62A	"	"	Clay loam	26	22¾	18.18	79
112	" " "	581B	"	"	Loose and mellow	27	27	20.67	89
113	" " "	503B	"	"	Clay loam	34	29	15.75	87
114	" " "	340A	"	Vilmorin	Dark loam	33	27½	18.70	80
130	" " "	385-3	"	From Chino Valley	Sandy	33	23	19.50	87
131	" " "	379-2	"	Vilmorin	"	26	34	14.87	81
132	" " "	380-3	"	Blabotier	"	40	30	16.83	84
133	" " "	384-7	"	Vilmorin	"	24	25	16.31	86
134	" " "	382-5	"	Kleinwanzlebener, Original	"	28	26	18.32	80
135	" " "	386-9	"	Wohanka	"	33	34	15.00	85
136	" " "	379-1	"	From Department Agriculture	"	34	28	18.19	82
137	" " "	383-6	"	Kleinwanzlebener	"	31	28	16.05	87
138	" " "	381-4	"	Wohanka Extrareichen	"	31	25	11.54	80
140	Robert Spence		Prost	Kleinwanzlebener	Clay loam	35	......	14.36	81
343	John Nason		Chesaning	"	Prairie loam	29	28	15.19	82
364	A. G. Conger		Brady	"	Black loam	33	......	15.64	79
396	J. G. Hickinger, Jr.		Frankenmuth	"	......	26	......	19.53	90

Results of cultivation of sugar beets in Michigan in 1897, with reports from experimenters and results of analysis of the sugar beets.

Lab. No.	Name.	Locality.	Variety of sugar beet.	Kind of soil.	Average weight of the beets in ounces.	Tons per acre.	Per cent. of sugar.	Purity.
40	Higgins & Lenders, 498A	Saginaw	Kleinwanzlebener	Sandy	37	23	16.99	84
41	" " " 562A	"	Vilmorin	Clay loam	30	30½	18.44	76
42	" " " 482B	"	Kleinwanzlebener	Clay and sand	40	......	16.54	84
43	" " " 569A	"	Vilmorin	Black sand	23	22½	16.67	80
44	" " " 192B	"	Kleinwanzlebener	Black sandy loam	25	23½	17.05	88
45	" " " 389A	"	"	Very poor	37	24	15.75	83
46	" " " 248B	"	"	Blue clay	34	23	17.07	83
47	" " " 199A	"	Vilmorin	Sandy loam	23	30	15.18	88
48	" " " 502A	"	Kleinwanzlebener	Clay loam	26	29	14.16	83
49	" " " 105B	"	Vilmorin	" "	25	18½	17.33	86
50	" " " 244B	"	Kleinwanzlebener	" "	34	19	18.02	80
51	" " " 210B	"	"	Sandy	16	20½	14.63	80
52	" " " 327B	"	Vilmorin	Black sand	40	40	16.02	90
53	" " " 3A	"	Kleinwanzlebener	Sand and clay	24	35	17.07	88
54	" " " 249A	"	"	Clay loam	33	18½	15.96	81
55	" " " 69B	"	"	Sandy loam	30	45	17.69	85
56	" " " 505B	"	"	Black sand	26	20	15.18	84
57	" " " 192A	"	"	" "	25	40	15.86	87
58	" " " 523B	"	"	Black sandy soil	19	18½	18.06	88
59	" " " 375A	"	"	Sandy loam	36	24	16.31	86
60	" " " 287B	"	Vilmorin	Mixed ground	20	31	17.49	86
61	" " " 501	"	Kleinwanzlebener	Clay loam	23	18½	19.15	86
62	" " " 3B	"	"	Sand and clay	21	35	16.03	80
63	" " " 497B	"	"	Sandy loam	44	29	15.35	85
64	" " " 248	"	"	Blue clay	24	23	18.83	87
65	" " " 46B	"	"	Sandy loam	21	22½	15.85	84
66	" " " 71	"	"	Sand and clay	32	20	16.67	85
67	" " " 85	"	"	Clay loam	25	16½	17.88	84
68	" " " 93B	"	Vilmorin	" "	20	71½?	22.83	91
69	" " " 249	"	Kleinwanzlebener	Clay	23	18½	15.87	86
70	" " " 288A	"	"	Hard clay	20	33½	14.94	79
71	" " " 122A	"	" Original	Sandy loam	21	21½	17.43	88
72	" " " 340B	"	Vilmorin	Dark loam	39	21	16.56	84
73	" " " 533	"	Kleinwanzlebener	Black sand	36	18½	14.43	84
74	" " " 3	"	"	......	28	35	18.33	86
75	" " " 531	"	"	Sandy	26	27	17.24	88
76	" " " 57B	"	"	Yellow clay	37	20	16.11	88
77	" " " 387	"	"	Sandy	30	25½	17.49	85
78	" " " 298	"	"	"	23	12½	10.81	78

79	" " "	569 B	"	Vilmorin	Black sand	19	37¾	18.94	93
80	" " "	25 B	"	"	Black loam	24	10¾	20.98	89
81	" " "	60 B	"	Kleinwanzlebener	Clay loam	33	34	17.83	82
82	" " "	97 B	"	Vilmorin	Sandy loam	38	24	17.05	88
83	" " "	116 A	"	Kleinwanzlebener	Clay loam	37	33⅓	16.23	85
84	" " "	120 A	"	Vilmorin	Sandy loam	30	18¾	16.02	81
85	" " "	90	"	Kleinwanzlebener	" "	20	38	19.58	88
86	" " "	120 B	"	Vilmorin	" "	27	18¾	20.18	88
87	" " "	322 B	"	Kleinwanzlebener	Muck	40	18½	10.54	75
88	" " "	288 A	"	"	Hard clay	23	28½	14.16	75
89	" " "	83 A	"	"	Clay loam	35	34	18.30	86
90	" " "	198 B	"	Vilmorin	Black loam	32	33½	18.72	76
91	" " "	8 A	"	Kleinwanzlebener	Sandy	35	30	21.22	90
92	" " "	199 B	"	Vilmorin	Sandy loam	21	30	16.62	89
93	" " "	23 A	"	"	Clay	31	30¾	18.58	80
94	" " "	363 B	"	Kleinwanzlebener	"	28		15.25	83
95	" " "	507 B	"	"	Black muck	28	25¾	14.31	75
96	" " "	497 A	"	"	Sandy	30	29	15.90	86
97	" " "	298 A	"	"	Sandy loam	20	12½	11.27	70
98	" " "	298 B	"	"	" "	29	12¾	17.30	85
99	" " "	93	"	Vilmorin	Clay loam	20	71½?	19.99	88
100	" " "	565	"	Kleinwanzlebener		22		16.19	86
101	" " "	457	"	"		33	39	12.75	77
102	" " "	507 B	"	"	Muck	28	25¾	18.80	83
103	" " "	69	"	"	Sandy loam	24	45	14.94	79
104	" " "	559 B	"	Vilmorin	" "	25	25	17.07	83
105	" " "	531 D	"	"	Loose and mellow	23	27	20.92	88
106	" " "	559 B	"	"	Sandy loam	24	25	15.85	87
107	" " "	23 B	"	"	Clay soil	32	40	11.87	70
108	" " "	210 A	"	Kleinwanzlebener	Sandy	23	56 ?	15.85	87
109	" " "	339 B	"	Vilmorin	Sandy loam	20	28	16.81	83
110	" " "	8 B	"	Kleinwanzlebener	Sandy	35	30	18.18	88
111	" " "	62 A	"	"	Clay loam	28	22½	18.18	79
112	" " "	581 B	"	"	Loose and mellow	27	27	20.67	89
113	" " "	502 B	"	"	Clay loam	34	29	15.75	87
114	" " "	340 A	"	Vilmorin	Dark loam	38	27½	18.70	80
130	" " "	385–8	"	From Chino Valley	Sandy	33	23	19.50	87
131	" " "	379–2	"	Vilmorin	"	26	34	14.87	81
132	" " "	380–8	"	Blabotier	"	40	30	16.83	84
133	" " "	384–7	"	Vilmorin	"	24	25	16.31	86
134	" " "	382–5	"	Kleinwanzlebener, Original	"	28	26	18.82	80
135	" " "	386–9	"	Wohanka	"	38	34	15.00	85
136	" " "	379–1	"	From Department Agriculture	"	34	28	18.19	82
137	" " "	383–6	"	Kleinwanzlebener	"	31	28	16.05	87
138	" " "	381–4	"	Wohanka Extrareichen	"	31	25	11.54	80
140	Robert Spence		Frost	Kleinwanzlebener	Clay loam	35		14.86	81
343	John Nason		Chesaning	"	Prairie loam	29	28	15.19	82
364	A. G. Conger		Brady	"	Black loam	33		15.64	79
396	J. G. Hickinger, Jr.		Frankenmuth	"		26		19.53	90

Results of cultivation of sugar beets in Michigan in 1897 with reports from experimenters and results of analysis of the sugar beets.

Lab. No.	Name.	Locality.	County.	Variety of sugar beets.	Kind of soil.	Average weight of the beets in ounces.	Tons per acre.	Per cent. of sugar.	Purity.
210	E. H. Marsh	Alpena	Alpena	Kleinwanzlebener	Clay loam	33	14	18.27	80
337	Joseph Bryan	Orchard Hill	"	"	Sandy loam	40	12½	16.75	80
155	Chas. Johnson	Rock River	Alger	"	Meadow bottom	10	10	14.23	80
218	Peter Gilbert	Sterling	Arenac	White Silesian	Sandy loam	28	7	18.85	77
	W. J. Wademan	Twining	"	Vilmorin		21		14.33	80
219	Dean W. Thrasher	Standish	"	Kleinwanzlebener	Deep sandy loam	18	26	17.27	86
197	Thos. Turner	Melita	"	"	Clay loam	28	15½	16.05	86
151	Frank Phillips	Saganing	"	White Sugar	Sandy loam	17	?	16.82	86
183	Orville Brooks	"	"	"Sugar Beet"		28		16.08	87
336	W. S. Lloyd	"	"	"Congressional"	Clay loam	14	14	19.06	90
342	Richard W. Lloyd	"	"	"	Sandy loam	17	12	20.78	90
188	C. V. Nash	Cheshire	Allegan	Kleinwanzlebener	" "	27	18	15.02	87
198	T. G. Adams	Shelbyville	"	"	" "	25	?	16.28	88
271	Franklin D. McVean	Monteith	"	"	" "	25	16	15.70	84
180	Robert Campbell	Mancelona	Antrim	"	Sandy	18	15	15.16	82
217	Fred Pfeiffer	Elk Rapids	"	"	"	21	20	16.79	82
126	C. B. Chatfield	Bay City	Bay	Vilmorin	Sandy loam	24	15	18.07	88
184	Andrew Faulds	Bentley	"	Kleinwanzlebener	Black sandy loam	31	?	11.83	81
202	Anthony Reder	Auburn	"	"	Heavy sand	56	16	16.93	90
203	Wm. Bentley & Sons	Bay City	"	Vilmorin		28		16.54	81
204	" " "	" "	"	"		32		16.86	84
205	" " "	" "	"	Imperial		22		18.47	80
206	" " "	" "	"	Vilmorin		25		14 22	80
253	Frank Rossman	" "	"			23		14.25	79
399	Bay County Land Office	" "	"	White Silesian	Black sandy soil	30	14	17.75	88
404	John B. Bushey	Auburn	"	Kleinwanzlebener	Dark sand	32	9	16.42	85
229	D. E. Groesbeck	Union City	Branch	"	Clay sand	19	?	18 07	84
256	Warren Boughton	Bronson	"	From Dept. of Agriculture	Sandy soil	21	17	17.55	85
413	E. F. Boughton	"	"	Wohanka	Sandy loam	26	25	14.25	82
385	John L. McKernan	L'Anse	Baraga	Kleinwanzlebener	" "	27	23	14.10	76
175	T. R. Chambers	Irving	Barry	"	" "	25	43½?	18.92	75
215	J. V. Bray	Middleville	"	"	Gravelly loam	44	14½	14.94	80
245	John E. Murphy	Bower's Mills	"	"	Sandy loam	27		16.48	88
258	C. E. Paul	Gaskill	"	"	Clay loam	23	16	14.25	82
272	Mrs. L. F. Moore	Coloma	Berrien	"	Sandy loam	28	?	19.64	85
150	Arno Hall	Watervliet	"	"	Light sandy loam	16	?	17.58	89
156	B. F. White	"	"	Vilmorin Imperial	Sand and gravel	17	15½	16.28	88
[illegible]	E. C. Hinman	Battle Creek	Calhoun	"Seed from Chino, Cal."	Sandy soil	30	27	18.99	80

231	Dennis McAllister	Penfield	"	Kleinwanzlebener	Sandy loam	33	14	17.81	87
289	Gilbert Nichols	Battle Creek	"	"	" "	20		19.68	83
233	C. C. McDermid	" "	"	"	" "	22	9	14.94	84
377	Thos. E. Haddon	Bedford	"	"	" "	27		12.49	77
235	T. L. Johnson	"	"	"	Sandy	43		16.11	87
228	H. S. McMaster	Dowagiac	Cass	Department of Agriculture	Sandy loam	24	15	15.02	57
128	M. J. Gard	Volinia	"	Kleinwanzlebener	Prairie	26	13¼	15.86	77
181	Geo. Smallet	Boyne	Charlevoix	"	Sandy loam	20	18	19.25	91
199	Jas. Harvey	South Avon	"	"	" "	21		18.18	90
220	Geo. Anderson	Charlevoix	"	"	Heavy clay	19	35	15.85	77
221	J. J. Robbins	Boyne Falls	"	"	Gravel loam	29	21	17.75	86
156	John Ward	Charlevoix	"	"	Heavy clay loam	25	28⅓	15.75	85
157	E. B. Ward	"	"	"	Clay loam	25	32	17.58	91
375	Geo. Ball	"	"	"	Sandy	30		18.75	88
171	Ed. Whitney	Clare	Clare	"	Sandy loam	26	20	16.54	88
141	W. H. Faxon	Ovid	Clinton	"	Light sand	29	16	18.91	80
172	Marion Tifft	DeWitt	"	"	Clay loam	18		16.48	88
251	R. B. Caruss	St. Johns	"	"	Sandy loam	29	11	17.75	89
273	A. Matthew	Maple Rapids	"	"	Sand and muck	32	18	15.40	80
209	O. Palmer	Grayling	Crawford	Vilmorin	Sand plains	16	23½	15.25	81
269	Leo V. Hildinger	Woodbury	Eaton	Kleinwanzlebener	Sandy loam	30		19.69	85
281	A. S. Merritt	Eaton Rapids	"	"	Sandy	30	14	17.43	84
186	Jerrie Mikesill	Charlotte	"	"	Clay	32	31	17.08	85
247	Joseph Shaw	"	"	"	Sandy loam	20	13	17.46	84
410	Benj. Shellhorn	Woodbury	"	"	Clay soil	27	30	15.85	79
154	Henry R. Miller	Petoskey	Emmet	"	Clay loam	29		15.08	83
149	D. Henry	Montrose	Genesee	"	Yellow sand	34	43	16.05	86
185	H. B. Latourette	Fenton	"	?	Alluvial bottom	59	?	7.82	71
196	L. J. Harris	Richfield	"	Kleinwanzlebener	Sandy loam	28	21½	18.83	84
200	Chas. W. Shayler	Bentley	"	"	" "	21		18.13	90
213	A. J. Daumur	Fenton	"	"French White"	Black loam	35	20	12.86	79
201	B. W. Benjamin	Flushing	"	Kleinwanzlebener	Gravelly	27	29	14.83	81
159	Wm. R. Fuller	Fife Lake	Gra'd Traverse	"	Clay and sand loam	25	7⅓	17.46	86
178	L. S. Walter	" "	" "	"	Sandy loam	26	24⅓	14.84	79
179	G. S. Stalker	Summit City	" "	"	" "	19	40?	13.44	79
214	J. B. Brown	Slights	" "	"	" "	26	?	17.07	88
216	H. Hoffman	"	" "	"	" "	28	?	15.40	82
249	Mrs. H. E. Wilsey	Summit City	" "	"	Garden soil	29	?	17.75	84
177	Geo. Roush	Traverse City	" "	"	Muck and sand	25	43?	14.88	80
280	I. N. Cowdrey	Ithaca	Gratiot	"	Clay loam	22	26	14.63	80
306	Geo. C. Titus	St. Louis	"	"	Sand and clay	27	35	18.83	87
313	Ray Fraker	Alma	"	"	Prairie soil	22	12	14.81	79
414	Geo. Gibson	Breckenridge	"	"	Black sandy loam	27	7⅓	15.40	81
129	J. F. Thissell	"	"	"	Sandy loam	14	9⅓	19.08	90
297	J. D. McCrimmon	St. Louis	"	"Sugar Beet"	Clay loam	29	?	14.30	80
283	Chas. E. Fuller	Osseo	Hillsdale	Kleinwanzlebener	Dark timber land	28	16	17.30	88

Results of cultivation of sugar beets in Michigan in 1897, with reports from experimenters and results of analysis of the sugar beets.

Lab. No.	Name.	Locality.	County.	Variety of sugar beets.	Kind of soil.	Average weight of the beets in ounces.	Tons per acre.	Per cent. of sugar.	Purity.
415	Chas. Mosher & Son	Mosherville	Hillsdale	Kleinwanzlebener	Heavy sand	20	8½	16.12	80
117	H. S. Worden	Sand Beach	Huron	Vilmorin	Clay loam	20	8¾	19.36	86
189	Bert Baur	Bayport	"	Kleinwanzlebener	" "	29	49 ?	18.65	86
190	John J. Murdock	Pigeon	"	"	" "	21	....	14.74	84
419	John Hoxtable	Sand Beach	"	"	Sand	19	23	18.89	86
421	R. A. Brown	" "	"	Vilmorin	Clay	23	19¼	17.18	85
....	Daniel Mooney	Ft. Gratiot	"	"	Clay loam	21	16½	16.00	85
152	R. V. McKeen	Lansing	Ingham	....	....	34	....	15.87	87
183	Milo E. Marsh	"	"	German	Sandy muck	29	34	12.66	76
226	August Dreger	Okemos	"	Gov't Kleinwanzlebener	Rich loam	34	14	16.02	81
293	Peter Karber	"	"	Kleinwanzlebener	Sandy	33	?	17.33	84
373	S. H. Foster	"	"	"	Red sand and clay	14	11	16.28	89
397	A. Ferle	Lansing	"	....	....	34	....	10.75	74
426	Leonard Powell	Okemos	"	Kleinwanzlebener	....	45	....	14.94	83
446	Harvey M. Young	Mason	"	"	Clay loam	14	30	18.05	88
1	Plot 1	Agrl. College	"	Gov't Kleinwanzlebener	Sandy loam	17	15	20.52	87
1½	" 1½	" "	"	" "	" "	15	18	17.24	88
2	" 2	" "	"	" "	" "	18	18	17.02	90
2½	" 2½	" "	"	" "	" "	16	14½	20.85	87
....	" 3	" "	"	" "	" "	20	17½	17.50	85
....	" 3½	" "	"	" "	" "	23	18	15.84	84
....	" 4	" "	"	" "	" "	17	15	17.55	87
....	" 4½	" "	"	" "	" "	15	17	16.05	89
....	" 5	" "	"	" "	" "	13	15	14.45	85
....	" 5½	" "	"	" "	" "	13	11	18.03	90
....	" 6	" "	"	" "	" "	14	9½	15.58	91
....	" 6½	" "	"	" "	" "	14	11	17.96	90
....	" 7	" "	"	" "	" "	13	13	17.04	88
....	" 7½	" "	"	" "	" "	12	8½	18.41	90
....	" 8	" "	"	" "	" "	14	10½	15.25	88
....	" 8½	" "	"	" "	" "	13	15	16.25	90
....	" 9	" "	"	" "	" "	14	19¼	17.47	85
....	" 9½	" "	"	" "	" "	14	9	16.05	89
....	" 10	" "	"	" "	" "	13	12	15.99	88
....	" 10½	" "	"	" "	" "	14	16	16.54	87
....	Field Culture	" "	"	Wohanka	Gravelly loam	12	11¾	15.22	86
....	" "	" "	"	Improved Kleinwanzlebener	" "	9	18	16.40	91
....	" "	" "	"	Original Kleinwanzlebener	" "	15	18¾	18.27	94

	" "	" "	"	Le Plus Riche	" "	19	14⅓	18.78	92
	" "	" "	"	Gov't Kleinwanzlebener	" "	11	15⅓	17.78	94
	" "	" "	"	Floto's Improved	" "	17	10	18.21	88
	" "	" "	"	Kleinwanzlebener	Muck	19		12.96	75
	" "	" "	"	Hoerning's Improved	Gravelly loam	14	12⅓	15.20	89
857	F. Greininger	Stambaugh	Iron	Kleinwanzlebener	Sandy	13	27	18.18	80
870	P. A. Wachs	Lake Odessa	Ionia	"	Clay loam	24	14	16.05	82
208	Alex. McKenzie	Campbell	"	"	Clay	25	?	16.73	84
818	P. G. Fellows	Lake Odessa	"	"	Gravelly loam	31	10	15.02	76
866	A. M. Gravella	Smyrna	"	"	Sandy loam	18		17.64	86
248	Leander Bellville	Whittemore	Iosco	"	Sand	37		16.99	88
254	A. Cataline	"	"			42		10.84	78
422	Dr. H. A. Goodale	East Tawas	"	Vilmorin	Sandy soil	14	23⅓	16.48	85
475	Geo. Putnam	Hale	"	"	Clay	23		16.48	82
476	A. C. Kay	East Tawas	"	Kleinwanzlebener ?	Sand	37		7.96	68
477	" "	" "	"	Vilmorin	"	37		10.31	64
859	Thos. Collin	Mt. Pleasant	Isabella	Kleinwanzlebener	Dark sand	37	18	15.64	85
461	Alexander Meyer	Shepherd	"	"	Black clay	32	50 ?	18 58	86
458	F. C. Dingman	Caldwell	"			29		15.02	76
463	J. E. Meyer	Shepherd	"	Vilmorin Improved ?	Black ?	32	30	7.11	62
176	F. J. Randall	Brooklyn	Jackson	Kleinwanzlebener	Sandy loam	23	18⅓	16.99	84
191	A. B. Cook Co., No. 3	"	"	?	?	38	?	6.18	68
192	" " " " 4	"	"	?	?	32	?	5.30	63
193	" " " " 5	"	"	?	?	50	?	7.46	74
194	" " " " 2	"	"	?	?	106	?	6.07	65
195	" " " " 1	"	"	?	?	76	?	6.83	70
872	F. J. Randall	"	"	Kleinwanzlebener	Sandy loam	30	18⅓	19.33	92
265	O. E. Clark	Comstock	Kalamazoo	"	" "	32	19	16.83	88
279	Adam Ehrmann	Kalamazoo	"	Sugar Beet	Clay loam	49	?	13.47	76
282	W. A. Keyser	"	"	Kleinwanzlebener	Gravelly loam	12		16.42	88
284	Geo. D. Cobb	Schoolcraft	"	"	Black muck	12		10.04	77
285	W. A. Brockway	Vicksburg	"	"	Black sandy loam	27	14	15.03	77
287	D. T. Dell	"	"	"	Clay openings	32	22⅓	16.05	81
288	" "	"	"	"	Timbered openings	23	23	15.08	80
290	G. M. Cheeney	"	"	"	Clay loam	24	14	13.19	76
292	John Williams	Williams	"	"	Sandy loam	24		18.45	89
307	Geo. F. Young	Schoolcraft	"	"	Sand	25		15.64	81
323	L. B. Welch	Portage	"	"	Sandy loam	18	17	16.56	86
326	Leander Cannon	Vicksburg	"	"	Heavy clay loam	33	19⅓	15.06	77
327	Thos. Hazard	Fulton	"	"	Sandy loam	28	20	16.54	84
334	C. W. Lemon	Vicksburg	"	"	Sandy loam	11	17	16 57	84
369	F. F. Perkins	Climax	"	"	Clay loam	9	10	18.89	90
371	M. F. Woodward	Schoolcraft	"	White French	Sandy loam	27	14⅓	14.20	80
409	Fred Van Zie	Kalamazoo	"	Kleinwanzlebener	Black muck	28		15.97	84
335	H. E. Hagan	South Boardman	Kalkaska	"	Plains	24	28	15.19	80
400	C. A. Goddard	Kalkaska	"	"	Pine plains	26	11	18.64	87

Results of cultivation of sugar beets in Michigan in 1897, with reports from experimenters and results of analysis of the sugar beets.

Lab. No.	Name.	Locality.	County.	Variety of sugar beets.	Kind of soil.	Average weight of the beets in ounces.	Tons per acre.	Per cent. of sugar.	Purity.
319	M. M. Thomas	Cedar Springs	Kent	Kleinwanzlebener	Sandy	21	24	18.88	91
320	Robt. S. Sowerby	Rockford	"	"	Sandy loam	29	15	16.88	85
323	C. Thomas	Cedar Springs	"	"	Sandy	16	21½	11.90	73
332	Hart Bradish	Grand Rapids	"	"	Clay loam	27		18.99	75
338	John E. Hoag	Cannonsburg	"	"	Sandy	15	48	15.96	85
339	D. C. Hooper	Logan	"	"	Clay loam	29	13½	16.28	84
350	W. H. Zylstra	Fisher's Station	"			31	20	16.92	87
368	E. L. Phelps	Cedar Springs	"	Kleinwanzlebener	Clay	37	26	15.96	85
374	Samuel R. Miller	Kent City	"	"	Sandy loam	24	17	11.90	79
388	David C. McLain	Edgerton	"	"	" "	26	17	16.81	85
396	J. K. Hilton	Ross	"	"	Muck	28	39	13.91	80
402	Nate Emmory	Kent City	"	"	Sand	11	?	17.81	86
407	Chas. Ennis	Cedar Springs	"	"	Sandy loam	12	21½	16.73	88
445	A. B. Fenton	Bradley	"	White Skin from Dept. Agr.	Reclaimed muck	20		12.16	77
451	John F. Nellist	Grand Rapids	"		Loose gravel	20	12	14.94	79
189	Geo. H. Miller	Ada	"	Kleinwanzlebener	Clay loam	17	24½	16.13	87
278	W. H. Stickney & Sons	Lapeer	Lapeer	"	Black clay loam	34	14	17.24	80
314	F. S. Porter	North Branch	"	"	Gravelly loam	15	19.5	18.18	88
312	Semira Tremain	Norrisville	Leelanaw	"	Sandy	23	5	19.25	89
444	August Kurtzhals	Good Harbor	"	"	Sandy loam	24	18½	19.88	88
383	Wm. Bruff	Oviatt	"	"	" "	24	20	17.18	90
259	Walter Clement	Adrian	Lenawee	French White	Sandy	23	15	12.60	84
260	" "	"	"	Vilmorin Imperial	"	15	15	17.07	86
261	" "	"	"	Kleinwanzlebener	"	19	15	18.07	88
262	" "	"	"	Congressional	"	20	15	16.79	88
379	R. S. Gillespie	Tecumseh	"	Kleinwanzlebener	Black sandy loam	30	18	15.29	80
324	Guy G. Bordon	Howell	Livingston	"	Gravel loam	21	28	14.94	80
330	Geo. Stowe	Unadilla	"	"	Sandy loam	24	31	13.74	80
363	John R. Pollock	Hessel	Mackinac	White Silesian	" "	38	13½	16.23	85
115	C. Patterson	Richmond	Macomb	Vilmorin	Clay loam	28		18.00	83
123	Lawrence Hosmer	Romeo	"	"	Sandy loam	23	18	19.06	86
	J. P. Marts	Mt. Clemens	"			53		13.31	78
128	C. A. Hulbert	Armada	"		Clay loam	31	60 ?	9.47	67
153	Bruce Phillips	Utica	"	Kleinwanzlebener	Muck and sand	31	48 ?	15.70	87
276	Wm. C. Smith	Washin[illegible]	"	"	Black clay loam	23	11½	17.94	88
309	Jas. S. Lawson	[illegible]	"	"	Heavy sand	17	19	14.51	83
483	H. A. Keeler	Richmond	"	Vilmorin	Clay loam	14	22½	23.44	93
909	[illegible]	Mt. Clemens	"	Kleinwanzlebener	Sandy loam	17	13	14.06	81

438	Joseph Dunsmore	Memphis	"	"		20		16.43	90
	D. F. Dysinger	"	"	Vilmorin		17		16.50	83
384	J. D. Maxted	Chief	Manistee	Kleinwanzlebener	Clay	19	57 ?	15.64	86
361	Hiram E. Scott	Manistee	"	"	Light sand	8	9	13.47	80
401	C. D. McMartin	Tanner	"	Congressional	Gravelly	23	28	18.89	87
398	Buckley & Douglas Lum. Co	Manistee	"	Kleinwanzlebener	Sandy loam	29	18½	20.92	91
460	A. W. Farr	Onekama	"	"	" "	52	15	15.40	81
468	J. W. Rhodes	"	"	"	Sand with some clay	23	37	18.24	88
403	Benjamin Fry	Custer	Mason	"	Sandy loam	27	32	17.94	91
246	Albert Vogel	Ludington	"	"	Sand	37		16.99	88
361	Jacob L. Gebhart	Custer	"	"	Sandy loam	28	32½	17.69	88
362	John E. Phillips	"	"	"	" "	36	32½	18.27	80
450	A. Vogel	Ludington	"			61		16.79	83
274	Benj. Davis	Big Rapids	Mecosta	Kleinwanzlebener	Sandy loam	26	22	16.43	88
345	Henry Schmidt	Crapo	"	"	Sand and gravel	28	13	17.64	90
398	Arnold Ely	Big Rapids	"	"	Sandy loam	27	37	15.29	76
394	D. N. Bromley	" "	"	"	" "	23	5	17.33	88
263	E. E. Shields	Ingalls	Menominee	"	River bottom	32	12	12.43	80
264	Geo. H. Benjamin	"	"	"	Heavy clay	19	10½	18.24	84
265	John Swanson	"	"	"	Sandy loam	15	30	16.37	84
266	J. F. Caldwell	Stephenson	"	"	Clay loam	24	23	17.55	85
267	August Anderson	Daggett	"	"	Pine and hard wood	35		18.30	89
268	Ira Carley	Ingalls	"	"	Sandy loam	18	25	16.56	83
286	J. E. Sayre	Midland	Midland	"	Black sandy loam	19	27	18.18	87
448	Hugh McMillan	La Porte	"	"	Clay loam	31	31½	17.07	86
178	John Howe	Lake City	Missaukee	White Sugar Beet	" "	27		15.79	84
411	W. P. Souder	Petersburg	Monroe	Kleinwanzlebener	Yellow sand	18	7½	16.93	86
358	W. A. French		"			31		15.90	83
381	John Dallard	Wyman	Montcalm	Kleinwanzlebener	Light sand	45		15.70	81
438	A. R. Isham	Butternut	"	"	Sandy loam	26	10½	19.58	86
382	Larse Larson	Holton	Muskegon	"	Sandy	17	21½	19.64	84
386	A. J. Minzey	"	"	"	Light, sandy	33	43 ?	14.57	83
125	H. Paulman	Ravenna	"	"	Sandy loam	18	16	15.64	88
127	Wm. Wendall	Muskegon	"	"	Gray sand	29	32	15.79	89
207	B. F. Aldrich	Whitehall	"			26		18.44	78
365	C. H. Proctor	Holton	"	Kleinwanzlebener	Black sand	25	55 ?	17.58	86
385	Fred Bluhm	Muskegon	"	"	Sandy loam	28	18½	17.75	87
447	Geo. N. Williams	"	"	"	" "	24	32½	18.83	88
354	T. B. Crocker	Twin Lake	"	"	" "	25	22½	18.21	76
252	W. E. Fulkerson	White Cloud	Newaygo	Vilmorin Imperial	Gravelly loam	30	16	18.38	80
277	Otis Williams	Sun	"	Kleinwanzlebener	Sand	30	10½	18.32	85
299	Geo. E. Hilton	Fremont	"	"	Clay	21		17.33	83
300	Geo. Harwood	"	"	"	Sandy loam	58	10½	10.83	74
301	Henry Rozema	"	"	"	" "	28	18	15.18	80
302	J. Castle	Fremont	"	"	Black loam	23	13	11.01	70
351	Dr. Derby	White Cloud	"	Vilmorin Improved	Sandy	18		12.60	72

Lab. No.	Name.	Locality.	County.	Variety of sugar beets.	Kind of soil.	Average weight of the beets in ounces.	Tons per acre.	Per cent. of sugar.	Purity.
856	Henry Becker	Hesperia	Newaygo	Kleinwanzlebener	Clay loam	31	33	15.40	80
465	John Fairbrothers	White Cloud	"	"	Sandy loam	28	31	16.99	85
464	Alton Fairbrothers	" "	"	"	Sandy soil	29	17	21.61	80
466	John O. Cook	" "	"	"	New ground	83	17	20.33	89
453	J. Castle	Fremont	"	"	Sandy loam	17		16.56	83
458	Geo. Harwood	"	"	"	Light sand	30		20.49	88
296	L. R. Hunter	South Lyon	Oakland	"	Sandy loam	23	15	17.18	88
811	Joseph L. Tuttle	Walled Lake	"	"	" "	27		9.47	81
289	Asar Brown	Pontiac	"	"	" "	20	10½	17.18	84
876	D. M. Wood	N. Farmington	"	"	" "	80	14	18.75	88
817	Wm. Evans	Holly	"	"	Gravelly loam	80		14.10	75
841	Frank Cuthbert	"	"	"	Clay loam	16	18½	12.33	74
270	J. Shannon	Wixom	"	"	" "	23	?	18.00	89
469	John Smith	Hart	Oceana	"French White"	Sandy loam	21	?	18.99	* 81
470	V. Simons	"	"	Silesian	Sandy	40		8.27	* 61
471	M. Melbrick	"	"	"	Sandy loam	32	?	7.69	* 54
472	N. L. Bird	Benona	"	Kleinwanzlebener	" "	15	?	18.07	* 84
473	S. W. Burdick	Hart	"	French White	Sandy	26	?	15.40	* 77
241	W. W. Gilmore	Shelby	"	" "	Sandy loom	35	13	11.22	78
243	" "	"	"	Vilmorin	" "	28	18	15.90	86
248	" "	"	"	Kleinwanzlebener	" "	81	18	18.49	88
808	H. Vanderwort	New Era	"			14		16.31	90
853	Chas. B. Davidson	Shelby	"	Kleinwanzlebener	Black sandy loam	19	14	19.25	88
463	G. M. Chamberlain	"	"		Sandy loam	28		18.06	88
454	J. Corgan, No. 1	Ontonagon	Ontonagon	Vilmorin	Sandy	50		13.74	75
455	" " " 2	"	"	"	Clay loam	54		14.68	76
456	" " " 3	"	"	"	Sandy loam	80		15.18	78
457	" " " 4	"	"	"	" "	84		17.07	87
847	Nelson Crysler	Reed City	Osceola	Kleinwanzlebener	" "	80	17½	19.00	89
405	Peter Peterson	LeRoy	"	"	" "	25	33	14.11	83
840	Ray Laughlin	Tustin	"	"	Sandy	23	10	17.07	81
250	W. H. Leslie	Vanderbilt	Otsego	"	Sandy loam	14	11½	18.00	90
291	A. A. Pompe	Hudsonville	Ottawa			81		15.64	77
810	C. C. Lillie	Coopersville	"	Kleinwanzlebener	Sandy loam	29	48	14.51	83
816	I. Wabeke	New Holland	"	"	Black loam	28		14.88	80
331	Doune Regnems	Holland	"	"	Sandy	81	48	16.08	83
860	L. DeWeert	"	"	"	Black sand	30	41	13.99	77
883	Mrs. T. C. Parsons	Coopersville	"	"	Sand and muck	26	18	14.10	71

367	M. Brand, Sr.	Vriesland	"	"	Dark clay	26	18	19.44	85
380	Wm. DeHoop	"	"	"	Black sand loam	26		15.40	81
406	O. B. Ryder	Agnew	"	"	Sand and gravel	28	26	18.32	89
408	W. B. Chittenden	Spring Lake	"	"	Black loam	28		19.98	90
412	Jas. L. Fairbanks	Holland	"	"	Clay loam	19	58 ?	18.00	84
124	Geo. W. Densmore	Hudsonville	"	"	Sand and clay loam	28	29½	14.42	82
459	J. H. Krommendyk	Zeeland	"			15		17.69	86
163	J. Caulkett	North Street	St. Clair	Vilmorin		30		16.31	80
160	David Atkins	Atkins	"	Kleinwanzlebener	Sand and gravel	39	25	18.58	88
170	" "	"	"	Vilmorin	" " "	36	25	20.24	93
161	Geo. Dobson	Lakeport	"	Kleinwanzlebener	Sandy loam	19	19	17.82	89
162	H. Broluskee	Ruby	"	"	Clay loam	37		16.48	83
164	Thos. Russell	Wadhams	"	Vilmorin	" "	25	22	18.42	86
166	J. Caulkett	Lockport	"	Kleinwanzlebener	Sandy loam	39	12	17.43	87
169	Stephen Lambkin	Avoca	"	Vilmorin	" "	31	19½	18.19	80
234	Martha J. Goodwent	Emmet	"			17		21.22	80
427	David McConchie	Ruby	"	Vilmorin	Sandy loam	28	26	18.43	86
429	D. Beard	"	"	"	" "	18	33 ?	19.88	85
430	W. Harrison	Capac	"	Kleinwanzlebener	" "	25	10½	18.00	88
431	John Cole	Lakeport	"	Vilmorin	" "	21	9½	18.58	88
434	Henry Keil	"	"	Kleinwanzlebener	Clay loam	27	54 ?	20.92	88
437	Albion Howe	Riley's Centre	"	Vilmorin	" "	24	12½	21.29	83
435	E. R. Perry, Sr.	Capac	"	"	Black sandy loam	20	12	14.62	77
438	Thos. Wilkes	Gardendale	"	Kleinwanzlebener	Clay loam	27	20	21.40	89
424	Alex. Atkins	Wadhams	"	"	Sand and clay	22	18½	20.18	86
116	Chas. Merritt	North Street	"			38		18.68	90
119	Adam Stein	Wadhams	"			18		16.02	81
121	Radike Bros.	St. Clair	"	Kleinwanzlebener	Clay loam	24	7½	16.54	83
	Joseph Kelfgen	Wales	"	Vilmorin	Sandy loam	19	24	15.17	75
	Albert Balfour	St. Clair	"	Kleinwanzlebener	Sandy	30	6	14.91	77
	F. A. Collins	Mt. Salem	"	Vilmorin		11		11.98	78
	W. Darling	Wales	"	"	Clay loam	14	24	16.45	81
	Richard Kilbourn	Elliott	"	"	Clay	10	14½	18.81	81
	Michael Myron	Blaine	"	Kleinwanzlebener	Clay loam	28	14	16.04	83
167	Thos. Russell	Wadhams	"	Vilmorin		21		16.25	80
425	John Cole	Lakeport	"	Kleinwanzlebener		26		19.90	88
436	Alex. Atkins	Wadhams	"	"		24		15.75	81
165	John Natus	Hasen's Island	"	White Perfection	Black muck & sand	31	5	14.10	75
449	Mrs. N. Ketchum	Factoryville	St. Joseph	Kleinwanzlebener	Heavy clay	24	14	12.16	76
168	Dennis Cremean	Applegate	Sanilac	Vilmorin	Sandy	31	19	18.45	85
187	Wm. Grimes	Speaker	"	Kleinwanzlebener	Clay loam	21	22	17.06	89
275	Henry Wisner	Chevington	"	"Congressional"	Clay	21	10	19.81	88
438	W. J. Martin	Croswell	"	Vilmorin	Loam	25	20	19.00	85
393	F. S. Stecker	"	"	Kleinwanzlebener	Clay, sand and loam	31	16	18.07	89
118	A. Shoemaker	Brown City	"	Vilmorin	Clay loam	30	21½	16.56	84

* Not considered in average on account of dried condition of the beets.

Results of cultivation of sugar beets in Michigan in 1897, with reports from experimenters and results of analysis of the sugar beets.

Lab. No.	Name.	Locality.	County.	Variety of sugar beets	Kind of soil.	Average weight of the beets in ounces.	Tons per acre.	Per cent. of sugar.	Purity.
120	David J. Decker	Croswell	Sanilac			26		19.33	81
329	Alex. Mann	Berkshire	"	Kleinwanzlebener	Clay with muck	53	47 ?	17.47	80
418	T. A. Hillman	Chevington	"		Clay loam	19		16.83	83
420	W. J. Martin	Croswell	"			19		20.96	89
....	Andrew Brown	Brown City	"	Vilmorin	Sandy clay	20	24	16.04	83
....	A. B. Cook	Owosso	Shiawassee	Kleinwanzlebener	Clay loam	30	10	18.89	89
390	T. D. Dewey	"	"	"	Black sandy loam	23	11	14.83	81
315	Chas. Goodwin	"	"	"	Gravel loam	21	22½	20.07	85
328	F. D. Bentley	"	"	"	Sandy loam	56	11¼	13.74	77
416	Robert Wood	Mayville	Tuscola	"	Clay loam	18	23½	18.94	89
227	T. Trowbridge	Decatur	Van Buren	"	Sandy loam	18	21½	18.19	80
257	Wm. H. Newell	Lawton	" "	"	" "	15	39 ?	15.79	84
321	Chas. H. Bolinger	Almena	" "	"	Sandy	16	21½	11.90	78
355	A. C. Glidden	Paw Paw	" "	"	Gravelly loam	20	9¼	14.42	82
244	Geo. W. English	Chelsea	Washtenaw	"	Clay loam	17	8	18.83	90
305	Martin Brining	Whittaker	"			26		12.08	73
387	J. Evarts Smith	Ypsilanti	"		Sandy loam	23	33	15.29	86
474	W. W. Blake	Ann Arbor	"	Kleinwanzlebener	" "	31		18.24	84
211	E. A. Bodden, No. 2	Leesville	Wayne	"	Clay	45	26	18.38	90
212	" " " 1	"	"	"	Gravelly loam	23	26	17.18	84
294	G. M. McCarty	Wayne	"	"	Black loam	24	20½	15.02	83
295	Geo. A. Welle	Flat Rock	"			27		17.49	83
344	Edward Bodden	Leesville	"			26		17.07	89
346	Jas. R. Clark	Belleville	"	Kleinwanzlebener	Sandy loam	32	27	17.55	86
417	S. H. Wilbur, Jr.	Wayne	"	"	" "	21	44 ?	21.46	90
370	T. E. Haddon	Redford	"	Pink colored beets		26		8.44	76
377	" "	"	"	Vilmorin		27		12.49	77
348	S. D. Davidson	Mesick	Wexford	Kleinwanzlebener	Sandy loam	31	48 ?	14.23	78
349	J. F. Henderson	Manton	"			25		17.13	87
439	John Harvey	Sherman	"	"Congressional"	Gravelly loam	30	23	14.74	79
440	Fred Hector	Cadillac	"	From Dep't of Agriculture	Sandy loam	24	43 ?	9.51	65
441	John Leeson	"	"	" " " "		37	?	16.62	80
442	John Cassity	Meauwataka	"	" " " "	Sandy loam	31	33½ ?	15.19	83
443	H. B. Sturtevant	Sherman	"			33		18.99	77
389	L. McCleah	Mesick	"	Lane's Imperial	Light sandy	21	43 ?	16.44	84
358	T. H. Callis	Manton	"	From Dep't of Agriculture	Sandy	26	14	13.47	80

RESULTS BY COUNTIES.

In order to present the results in the different sections of the State, Table II is inserted, giving the number of samples sent to the Station from each county, the average per cent of sugar and coefficient of purity, of all samples sent, and a corrected table in which the samples grown on the wrong kind of soil, or with poor seed, are omitted. Seed was distributed in sixty-eight counties, and from the table below it will be seen that samples have been received from sixty-four of them. The average per cent of sugar in the beets of the whole State, when grown on the proper kind of soil and from the right kind of seed, is 16.40, and the coefficient of purity is 84. This coefficient of purity signifies that of the whole amount of materials in solution in the sap of the beet, 84 per cent is sugar and only 16 per cent is gummy, saline or non-saccharine matter. An average of 16.40 per cent of sugar for the whole State, far exceeding the best districts in France and Germany, is both surprising and gratifying.

TABLE II.—*Results by counties.*

Counties.	Total number of samples.	Per cent. of sugar in them.	Coefficient of purity.	Samples rejected for bad soil or seed.	No. of samples on right soil and proper seed.	Per cent of sugar in such samples.	Coefficient of purity.
Alger	1	14.23	80	0	1	14.23	80
Allegan	3	15.67	86	0	3	15.67	86
Alpena	2	15.01	80	0	2	15.01	80
Antrim	2	15.97	83	0	2	15.97	83
Arenac	8	16.77	85	0	8	16.77	85
Baraga	1	14.10	76	0	1	14.10	76
Barry	4	14.90	81	0	4	14.90	81
Bay	10	15.53	84	1	9	16.00	84
Berrien	3	17.83	87	0	3	17.83	87
Branch	3	16.62	84	0	3	16.62	84
Calhoun	6	15.82	84	0	6	15.83	84
Cass	2	15.44	82	0	2	15.44	83
Charlevoix	7	17.53	87	0	7	17.58	87
Clare	1	16.80	84	0	1	16.80	84
Clinton	4	15.89	84	1	3	16.05	86
Crawford	1	15.35	81	0	1	15.85	81
Eaton	5	17.50	83	0	5	17.50	83
Emmet	1	15.03	83	0	1	15.03	83
Genesee	6	14.75	82	1	5	16.14	84
Grand Traverse	7	15.75	83	2	5	15.91	83
Gratiot	6	16.09	83	0	6	16.09	83
Hillsdale	2	16.71	84	0	2	16.71	84
Huron	6	17.47	85	0	6	17.47	85
Ingham	36	16.43	87	1	35	16.53	87
Ionia	4	16.36	82	0	4	16.36	83
Iosco	6	13.18	77	1	5	14.22	79
Iron	1	13.18	80	0	1	13.18	80
Isabella	4	14.09	78	1	3	16.41	83
Jackson	7	9.74	74	5	2	13.16	86
Kalamazoo	16	15.45	83	2	14	15.87	83

TABLE II.—CONCLUDED.—*Results by counties.*

Counties.	Total number of samples.	Per cent of sugar in them.	Coefficient of purity.	Samples rejected for bad soil or seed.	No. of samples on right soil and proper seed.	Per cent of sugar in such samples.	Coefficient of purity.
Kalkaska	2	16.91	83	0	2	16.91	83
Kent	16	15.55	83	2	14	15.85	84
Lapeer	2	17.71	84	0	2	17.71	84
Leelanaw	3	18.77	89	0	3	18.77	89
Lenawee	5	15.96	85	0	5	15.96	85
Livingston	2	14.34	80	0	2	14.34	80
Mackinac	1	16.22	85	0	1	16.22	85
Macomb	11	16.11	82	2	9	16.91	83
Manistee	6	17.09	84	0	6	17.09	84
Mason	5	16.54	85	0	5	16.84	85
Mecosta	4	16.67	84	0	4	16.67	84
Menominee	6	16.58	84	0	6	16.58	84
Midland	2	17.62	86	0	2	17.62	86
Missaukee	1	15.79	84	0	1	15.79	84
Monroe	2	16.41	84	0	2	16.41	84
Montcalm	2	17.64	83	0	2	17.64	83
Muskegon	9	16.08	85	0	9	16.08	85
Newaygo	13	16.11	81	1	12	16.54	81
Oakland	7	15.29	83	1	6	16.26	83
Oceana	* 11	16.54	86	0	11	16.54	86
Ontonagon	4	15.15	79	0	4	15.15	79
Osceola	3	16.55	85	0	3	16.55	85
Otsego	1	18.00	90	0	1	18.00	90
Ottawa	15	16.47	83	0	15	16.47	83
Saginaw	127	15.90	84	4	123	16.13	84
St. Clair	81	17.58	88	1	80	17.64	88
St. Joseph	1	12.16	76	0	1	12.16	76
Sanilac	11	18.15	86	0	11	18.15	86
Shiawassee	4	16.89	83	0	4	16.89	83
Tuscola	1	18.94	89	0	1	18.94	89
Van Buren	4	18.82	80	0	4	18.82	80
Washtenaw	4	16.10	84	0	4	16.10	84
Wayne	9	16.12	84	1	8	17.05	85
Wexford	9	14.59	79	1	8	15.25	81
Sixty-four counties	493				465		
Average		16.08	83			16.40	84

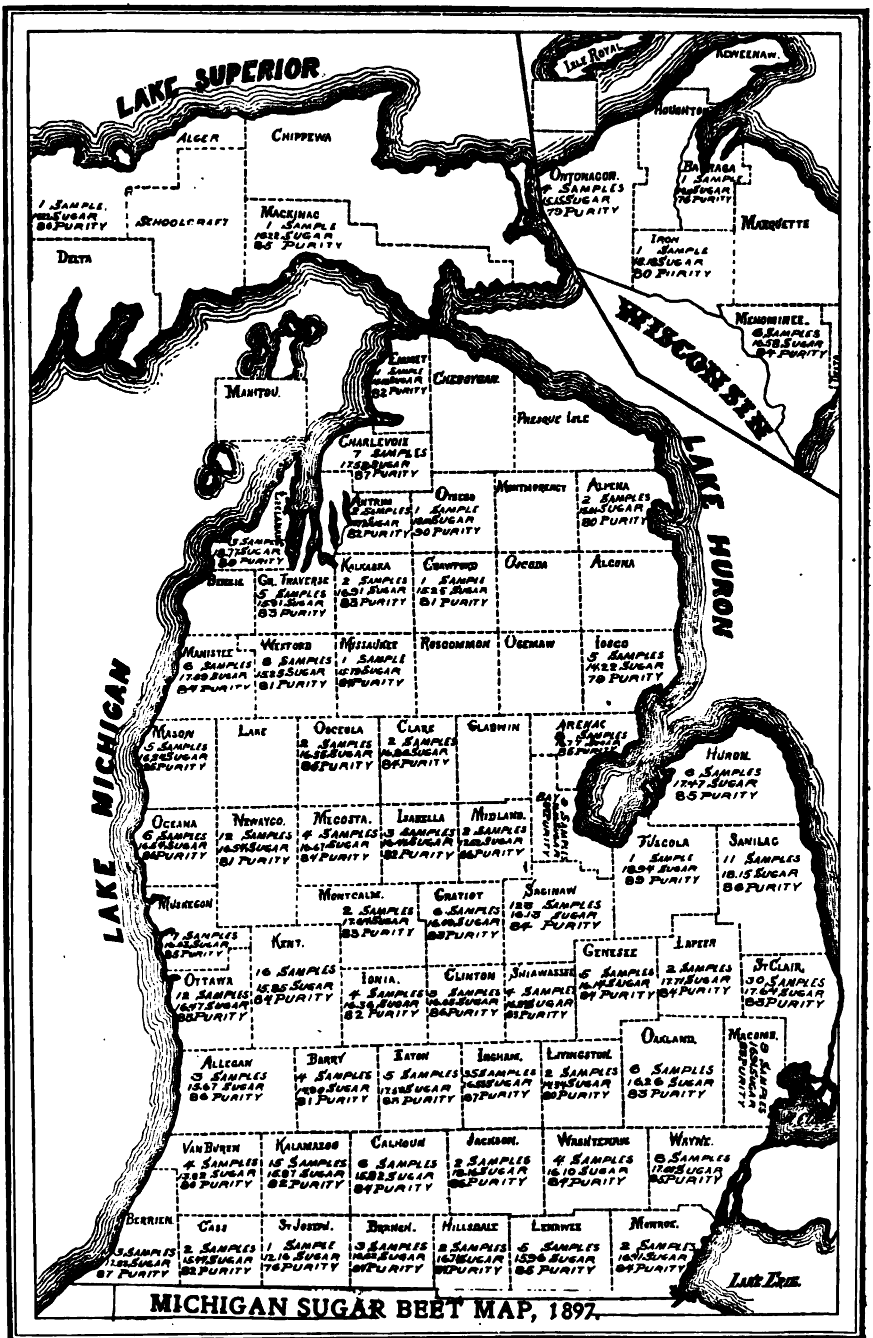
* Five samples from Oceana county are not included in results of analysis because they were dried and damaged by keeping.

MICHIGAN SUGAR BEET MAP, 1897.

To present the various facts embraced in the preceding tables relating to the growth of sugar beets in this State in 1897 in such shape that they can be seen at a glance, a sugar beet map is here inserted which shows the leading facts in regard to the experiments on this crop in our State for the year 1897.

This map shows by counties the number of samples of beets sent to the Experiment Station, the average content of sugar, and the coefficient of purity. The map speaks for itself.

MICHIGAN SUGAR BEET MAP, 1897.



TONS OF BEETS PER ACRE.

An effort was made to find the yield of sugar beets in different localities in the State by sending out blanks giving directions to measure off sixty-six feet in the row where these rows were eighteen inches apart, to count the number of beets, and to give the weight in pounds of the beets after removing the necks and tops. The estimate of the pounds per acre was to be made by multiplying the weight of the beets in this sixty-six feet of row by 435.6; by dividing this product by two thousand we would find the number of tons of beet roots to the acre. Many persons seem to have reported the number of pounds gathered from the whole plot, instead of the pounds from a row of sixty-six feet. The calculation shows some astonishing results in tons per acre, ranging from five to three hundred and forty-three tons. Requests for revised estimates have been in most cases without success. The report of large yields above twenty tons to the acre must be viewed with suspicion and the estimates considered very doubtful. In a large number of cases, however, great care has been employed to give accurate results, and for this care the people of the State are grateful.

From the results of careful measurements at the Station farm, and from the results of many careful and accurate experiments elsewhere, it would not be safe to place the range of yields per acre for 1897 higher than from twelve to eighteen tons.

IS THE SUGAR BEET AN EXHAUSTING CROP?

Before the farmer will make a radical change in his crop rotation, by bringing in the sugar beet, he will naturally ask what the influence of the new crop on the fertility of his farm will be. When the entire crop is removed from the field it is unquestionably exhausting, carrying off a large amount of fertilizing material, especially potash and phosphates. The leaves and crown contain a relatively larger amount of fertilizing materials than does the same weight of roots. To prevent unnecessary depletion, it is said that in certain districts the manufacturers require the farmers not to remove the leaves from the field, unless they are used as fodder and their fertilizing ingredients thus returned to the soil as manure. If this is done, and the beet pulp or residue after extracting the sugar is used as food for cattle, and in this way returned to the soil, there is absolutely no loss of fertilizing materials, and no farm crop so little exhausts the soil as sugar beets. Where there is nothing sold off the farm but the sugar, the crop removes no fertilizing material whatever. While sugar is valuable as food, it contains no element of fertility, no potash, lime, phosphate, nitrogen or other manurial material. It consists of carbon, oxygen and hydrogen, the elements taken up by the plant from the air, directly or indirectly; in selling the sugar, therefore, the farmer is selling wind and water only. In France the raising of sugar beets for the factory, where everything but the sugar was kept on the farm, has resulted in increasing the fertility of the soil, and has promoted the agricultural prosperity of the district. The beet

pulp as it comes from the factory is found to be a most valuable food for dairy and fattening stock.

At Grand Island, Neb., fine herds of fattening steers have been fed nothing but beet pulp and prairie hay and have laid on flesh at a rapid rate. The quality of meat was said to be superior. The pulp retains enough sugar to make it a very palatable food for stock. As a matter of fact, however, the farmers of Nebraska have been rather slow to take advantage of this addition to the ration of their cattle.

R. M. Allen, the general manager of the Standard Cattle Company, of Ames, Nebraska, has been experimenting with feeding pulp to cattle. In the winter of 1892-3 he fed two hundred and seventy-five head of cattle under many difficulties, and in several ways the results were unsatisfactory and incomplete. In a letter received at the Station early in November, Mr. Allen writes: "A number of cattle were fed beet pulp, corn silage and hay alone for four months, making the cheapest ration we ever fed. Other cattle were fed on a hundred pounds of pulp and six pounds of mixed cornmeal and ground oil cake; other cattle on fifty pounds of pulp and ten of meal, all cattle getting hay."

The only things that were decided by the experiment were:

"First, That the cattle would eat as much as a hundred pounds of pulp a day;

"Second, That they eat pulp with evident satisfaction and great relish;

"Third, That they consume very little or no water at all while eating pulp.

"Other points as to which I feel satisfied in my own mind, but which perhaps I cannot clearly demonstrate, are, that the use of pulp will effect a valuable saving of other food, both hay and grain, and that in the feeding of cattle for beef, by the use of pulp we can probably effect an economy of twenty to thirty per cent of the total cost of food. In years of drouth, when food stuffs are very high, the saving will be a very valuable one indeed. Pulp is very bulky and costly to transport, and expensive to handle. These charges, however, cut no figure with farmers delivering beets to a factory, who can as well as not take back a load of pulp to their farm. Pulp can be kept very easily indeed, as it becomes extremely compact and sours or ferments slightly. A large pile can even be left out doors in very cold weather, and while a crust eight or ten inches will freeze on the outside the inside will remain in good condition.

"Some of these cattle, after being fed four months, were sold in Chicago. Spayed heifers dressed out 60 per cent, and steers 62.2 per cent, favorably reported on by Swift & Co.

"Prof. Nicholson of Lincoln, Neb., analyzed some pulp for me with the following results:

"Organic matter, 10.78 per cent.
"Digestible protein, .37 per cent.
"Digestible crude fibre, 1.18 per cent.
"Digestible N. free extract, 3.49 per cent.
"Digestible fat, .06 per cent.
"Nutritive ratio, 1:7.1.

"I made at the same time a small experiment in feeding molasses, for the sole purpose of finding out if cattle would eat it. They quickly got on quite a feed of molasses and it is possible that some time this may become a cattle food in this country.

"All pulp should properly be fed in a barn where it cannot freeze and with other foods. During the earlier part of the feeding period, for instance, for three or four months out of six, it may be fed largely with a comparatively small feed of grain, although hay should always be fed with it. Toward the end of the feeding period the proportion of grain should be gradually increased and that of the pulp diminished for finishing the cattle for market.

"I attach the greatest possible importance in value to the use of beet pulp in beef production, and no doubt it will prove equally valuable in the dairy industry. Its value in feeding animals is one of the reasons why the production of sugar itself may find a firmer and more profitable location where dairy or beef animals are fed than in other sections where there are not so many animals to feed."

A letter from I. R. Alter, President of the Union Stock Yards Co., Grand Island, Neb., includes the following statement of his experience with the pulp: "I fed three hundred, three and four year old western steers in 1891, the first year our factory opened; of course I had no experience in feeding pulp, but I soon found that cattle were very fond of it, I think they will leave any other food known and eat it. As to the fattening quality, of course, when fed alone, it is almost valueless, though I believe stock would winter on it. Mixed with a cut feed of hay or straw or cornstalks, on which corn meal, bran or some other grain food is placed, it makes a ration which fattens very rapidly. By feeding the usual amount of meal, with seventy-five to a hundred pounds of this pulp per day per steer, the fattening period will be shortened at least thirty days, in other words you can get as good results in four months with pulp as you could in five without it. I think steers will eat as much grain food per day or more with the pulp than they will without it. It is a great 'conditioner' and appetizer, and we find the older it is the better the results. It will keep a number of years in the silo or piled up on top of the ground. It will turn black and spoil as far as the air goes through, which is from eight to ten inches. It will reduce in bulk fully one-half and grow as much richer. There are a number of big sheep and cattle feeders here, all of whom use it more or less. If anything, it is better for sheep than cattle."

Our consuls in the sugar producing districts of Europe call special attention to the need of combining the feeding of stock with the growing of sugar beets. While the leaves are good fodder, the pulp in particular should be fed to dairy stock, greatly promoting the production of milk, or to stock fitting for the shambles furnishing beef of the highest quality.

The thorough cultivation required in raising a crop of beets admirably fits the soil for the following crop. In France, no preparation of the soil for a crop of wheat is considered equal to the raising of a crop of beets. Sugar beets are therefore seen to be an enriching crop to the land, fitting admirably into our scheme of rotation, suited

to our soil and climate, a cash crop, producing a material in large demand but now imported from abroad.

THE FACTORY.

To secure to the farmer the benefits of this sugar beet industry, a factory is required, to work up the beets and extract the sugar. This is the most serious problem of the whole matter. It involves an outlay of capital that to the farmer seems excessive and useless. The manufacturer, to succeed, must have the best machinery that the world can produce, the most labor saving, the least expensive to operate and the one that will extract the largest amount of sugar of best commercial quality from the beets. He is in competition with the best machinery, and highest skill of the race. No old and discarded apparatus however useful in former years will serve his turn. A first class, up-to-date sugar plant cannot be secured for less than $300,000, add to that $100,000 for buildings and working capital and you have the lowest price for which a successful plant can be established. It is worse than folly to talk about putting up a cheap plant and making sugar in a small way.

In the second place the factory requires a good supply of rich sugar beets. This supply must be certain year after year. It is estimated that a crop of 3,500 acres of beets will be required each year to properly stock a sugar factory.

The other requirements of a factory, plenty of good water (2,000,000 gallons a day), cheap fuel, plenty of limestone in the immediate vicinity of the factory and finally good railroad facilities, will be looked after by the manufacturers themselves.

THE FUTURE OF SUGAR BEET GROWING IN MICHIGAN.

The results secured in growing sugar beets in this State both in 1891 and 1897 show that the climatic and soil conditions for their growth in our State are full of promise. Even the results in counties in the upper peninsula, where promising results would not be expected, are surprising, both in the amount of sugar and the purity of the juice. Large sections of the Lower Peninsula show results far in advance of the best beet sugar districts in France and Germany and equal to the best in our own country. The commonwealth holds out her encouraging hand in the bounty law offering a bonus of one cent a pound on beet sugar made in this State, as shown by act No. 48 of the session laws of 1897, which is here given in full:

[No. 48.]

AN ACT to provide for the encouragement of the manufacture of beet sugar and to provide a compensation therefor and to make an appropriation therefor.

SECTION 1. *The People of the State of Michigan enact,* That there shall be paid out of the State Treasury to any person, firm or corporation engaged in the manufacture in the State of Michigan of sugar from sugar beets grown in the State of Michigan one cent per pound upon each and every pound of sugar so manufactured under the conditions and restrictions hereinafter provided.

SEC 2. No money shall be paid for sugar so manufactured unless such sugar shall have been so manufactured in this State and from beets grown in the State of Michigan, and unless such sugar shall contain at least ninety per cent crystallized sugar, and the manufacturer shall produce good and sufficient receipts and vouchers to show that at least four dollars per ton of twenty hundred pounds has actually been paid for all beets purchased containing twelve per cent of sugar, said twelve per cent being the basis for valuation of the purchase price of four dollars per ton. The quantity and quality of sugar upon which all of said bounty is claimed shall be determined by the Commissioner of the State Land Office, with whom all claimants shall from time to time file verified statements showing the quantity and quality of sugar so manufactured by them, the price paid the producer for the beets actually produced in this State, upon which said bounty is claimed.

SEC. 3. The persons, firms or corporations so intending to engage in the manufacture of beet sugar in this State shall, before commencing the same, file a statement with the Commissioner of the State Land Office setting forth their proposed undertaking, the capacity of their manufactory, the number of tons of beets they intend to manufacture per annum, and request said Commissioner of the State Land Office to appoint a suitable weighman and inspector as hereinafter provided.

SEC. 4. It shall be the duty of the Commissioner of the State Land Office to appoint a resident weighman and inspector and such assistants as may be necessary in each town where it shall appear to him from the application of the persons, firms or corporations so engaged or intending to engage in the manufacture of beet sugar, that such weighman and inspector is needed, and in all cases where the output of persons, firms and corporations engaged in the manufacture of beet sugar in this State shall aggregate or exceed two thousand pounds per day, and such weighman and inspector shall weigh all beets received by such persons, firms or corporations engaged in the manufacture of beet sugar, and keep an accurate account of the same, with each and every purchaser of sugar beets and make such examination and test as to the quantity and quality of the sugar so manufactured as he may deem proper in arriving at the standard of sugar in each town, so manufactured by such persons, firms or corporations. The sugar

thus manufactured shall, under the direction of said weighman and inspector, be placed in original packages, which shall be examined, weighed and branded by him by a suitable brand showing the quantity and quality contained in each of said packages of which an accurate account shall be by him filed in the office of the Commissioner of the State Land Office.

Sec. 5. The compensation and fees for such services, above provided for, to be performed by said weighman and inspector and assistants, shall not exceed one-eighth of one cent per pound for the beet sugar so examined, weighed and branded by him, nor shall they receive to exceed the sum of three dollars per day for any one day's service actually performed as such weighman and inspector or assistant. He shall give a bond with good and sufficient sureties in the sum of not less than two thousand dollars to the State of Michigan, contingent upon the faithful performance of his duties, said bond to be approved by the Secretary of State, and he shall also take, subscribe and file in the office of the Secretary of State the constitutional oath of office. The said fees of compensation together with the cost of said brand and all analyses that the said weighman and inspector shall be required to make shall be borne and paid by the persons, firm or corporation claimant of said money; the said weighman and inspector shall perform all duties pertaining to his position in an impartial manner, and shall furnish and file with the Commissioner of the State Land Office, also with the manufacturer of said beet sugar, a monthly statement in duplicate of all sugar so manufactured by said person, firm or corporation. The said weighman and inspector shall, upon receipt of beets at such manufactory, select such samples of beets as he deems fair and equitable, and shall keep an accurate record of the gross weight of said samples, and shall estimate the per cent of said gross weight to be deducted therefrom as a reasonable and fair allowance for dirt and dockage, and he shall also test, or cause to be tested, said samples to ascertain the true per cent of sugar they contain, and make a record of the same. All beets from which samples have been taken shall be promptly weighed and an accurate record of the gross weights of the same shall be kept, also of the number of pounds to be deducted for dirt and dockage as fixed by the per cent of dirt and dockage of the samples, and also of the pounds net weight so obtained, and said net weight and the per cent of sugar as determined by the test of the samples shall be the basis of settlement between the buyer and seller, and in order to obtain the bounty provided by this act the buyer must pay at least four dollars per ton for beets containing twelve per cent of sugar, and a sum proportionate to that amount shall be paid for beets containing a greater or less per cent of sugar.

Sec. 6. When any claim arising under this act is filed, verified and approved by the Commissioner of the State Land Office as hereinafter provided, he shall verify the same to the Auditor General of the State, who shall draw a warrant upon the State Treasurer for the amount thereof payable to the person, firm or corporation to whom said sum or sums are due.

SEC. 7. That the sum of ten thousand dollars be and the same is hereby appropriated from the general fund in the State Treasury, not otherwise appropriated, to be known as the beet sugar fund, and to be expended under the direction of the Commissioner of the State Land Office as herein provided and the money for payment under this act shall be drawn from the State Treasury on the requisition of the Commissioner of the State Land Office, which shall be presented to the Auditor General, who shall draw his warrant on the State Treasurer therefor, and the Auditor General shall incorporate in the State tax for the year eighteen hundred and ninety-seven the sum of five thousand dollars, and for the year eighteen hundred and ninety-eight a like sum of five thousand dollars to be assessed, levied and collected as other State taxes are assessed, levied and collected, which sum when collected shall be placed to the credit of the general fund to reimburse it for the sum herein appropriated: *Provided*, That if the amount of bounty shall exceed the amount of ten thousand dollars for the years eighteen hundred and ninety-seven and eighteen hundred and ninety-eight; that the deficit be paid from the general fund not otherwise appropriated

SEC. 8. Every person, firm or corporation that shall erect and have in operation in this State a factory for the manufacture of sugar from beets with a capacity of two thousand pounds of sugar or upwards per day while this act is in force shall be entitled to receive from the State the sum of one cent per pound for all sugar manufactured from beets at such factory for a period of at least seven years from the taking effect of this act.

Approved March 26, 1897.

CONCLUSIONS.

The results of the experiments carried on in 1897 are very encouraging in many respects.

1st. The labor cost of growing an acre of beets under adverse conditions, reckoning the cost as twenty-five cents an hour for man and team, twelve and one-half cents an hour for a man, and eight cents for a boy, was $29.40.

2nd. The average yield per acre on the College farm was fourteen tons, three hundred and twenty-eight pounds.

3rd. The soil and climate of a large part of Michigan are well adapted to raising sugar beets for manufacturing purposes.